THE IMPACT OF THE MEDICARE SHARED SAVINGS PROGRAM ON STROKE OUTCOMES: FINDINGS FROM GET WITH THE GUIDELINES–STROKE REGISTRY

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A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Health Policy and Management in the Gillings School of Global Public Health.

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ABSTRACT

Brystana G. Kaufman: The Impact of the Medicare Shared Savings Program on Stroke Outcomes: Findings from Get With the Guidelines–Stroke Registry
(Under the direction of Sally Stearns)

Background: Over 900 Accountable Care Organizations (ACOs) have been created since 2010, and projections estimate that ACOs will manage the care for about one-third of Americans by 2025, however the impact of the MSSP on quality of care and patient outcomes is unclear.

Objective: This study compared outcomes before and after MSSP implementation for patients who were either (1) discharged from hospitals that chose to participate (N=273) versus not participate(N=1,490) in MSSP or (2) assigned by Centers for Medicare & Medicaid Services (CMS) to a MSSP ACO versus not. I hypothesized that MSSP ACO participation would be associated with reduced inpatient utilization and improved outcomes of care.

Methods: Using a difference-in-difference (DD) design, I evaluated outcomes associated with MSSP in a national inpatient stroke registry, Get With The Guidelines (GWTG)–Stroke, linked with Medicare claims for 2010–2015. Usage outcomes of discharge to home, number of hospital admissions, and Days Alive and Out of Hospital (DAOH) were modeled using negative binomial models with a log link and offset. Outcomes of all-cause rehospitalization, recurrent stroke, and all-cause mortality were modeled using Cox proportional hazards models. Outcomes of CMO or hospice enrollment within two weeks, hospice use within one year of hospitalization, hospice enrollment within seven days of death, and live discharge from hospice were modeled

using logistic regression. Except for discharge destination, all outcomes were followed for up to one year following discharge, with appropriate adjustment for death.

Key Findings: I found no evidence that hospital participation in the MSSP decreased inpatient use among stroke patients in the year following discharge, however beneficiary ACO alignment was associated with increases in subsequent admissions. Among patients most likely to benefit from palliative care, MSSP increased hospice enrollment and inpatient comfort measures without increasing rates of live discharge.

Conclusion: Except for increased use of palliative care among stroke patients, current quality metrics and incentives in MSSP contracts may not be sufficient to generate changes in post-stroke care.

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This dissertation is dedicated to my children, through whose births I became aware of the opportunity for improvement in the value of the care provided in the United States healthcare system, and my husband, who supported my leap into the strange world known as academia. He never doubted I would emerge successful, and the reason I did is largely due to his confidence when mine wavered.

I owe the completion of this work to the many mentors, colleagues, and funders who supported this project and my development as a researcher.

First I thank my dissertation committee: Sally Stearns, Emily O'Brien, Morris Weinberger, Mark Holmes, and Ying Xian. Each of them has played a remarkable role in my progression to this stage. Before I knew where I wanted to be in the public health labyrinth, Morris advised me, wisely, to enter the Master's program where I gained insight and confidence. Before I had a curriculum vitae, Mark gave me an opportunity to practice and learn from the best researchers who of course worked at the North Carolina Rural Health Research Center (shout out to George Pink). Sally has been in the trenches with me as I struggled through my first complex claims analyses in my Master's project, and she supported my vision for this dissertation work and made it better every step of the way. Emily was a key contributor to the design of my study, encouraging me to be ambitious and connecting me with the people and data that made my ideas come to life. Ying has provided essential clinical perspective and data knowledge and, in addition, I appreciate his encouragement and support in my transition into the next stage of my research career.

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I appreciate the generous funding that provided the resources and time for me to complete this study. First, the Duke-Margolis center funded the hospice data that were needed for Aim 3. Supplemental funding for consulting, administration, and travel was provided through the Executive Director Pathway Award at the Duke Clinical Research Institute. The DCRI pre-doctoral fellowship program gave me access to all of these resources, and I cannot thank Asheley Skinner enough for her role in establishing this program.

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"Knowing is not enough; we must apply.

Willing is not enough; we must do."

—Goethe

PREFACE

This dissertation is organized in a non-traditional format. The first chapter provides a brief introduction to the topic and the specific aims of the dissertation. Chapter 2 includes the conceptual model and an overview of the approach taken in each study aim. Chapters 3, 4, and 5 are manuscripts for the three study aims, intended to stand alone as publishable manuscripts and thus have redundancies with other chapters. Chapter 6 provides a summary of findings and policy implications and suggestions for future research.

The Get With The Guidelines®–Stroke (GWTG–Stroke) program is provided by the American Heart Association/American Stroke Association. GWTG–Stroke is sponsored, in part, by Medtronic and has been funded in the past through support from Boeringher-Ingelheim, Merck, Bristol-Myers Squib/Sanofi Pharmaceutical Partnership, Janseen Pharmaceutical Companies of Johnson & Johnson and the AHA Pharmaceutical Roundtable.

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LIST OF ABBREVIATIONS

ACO	Accountable Care Organization
CMS	Centers for Medicaid and Medicare Services
FFS	Fee for service Medicare Beneficiaries
GWTG	Get With The Guidelines®
HH	Home Health
IP	Inpatient
IRF	Inpatient Rehabilitation Facility
MA	Medicare Advantage
MSSP	Medicare Shared Savings Program
PAC	Post Acute Care
OP	Outpatient
SNF	Skilled Nursing Facility

CHAPTER 1. INTRODUCTION

1.1 Background

Since 2010, at least 900 Accountable Care Organizations (ACOs) have formed over 1,300 payment contracts with public and commercial payers, and Medicare accounted for 563 of those contracts in 2017.[1-3] The Centers for Medicare and Medicaid Services (CMS) implemented the Medicare Shared Savings Program (MSSP) to allow ACOs to retain a portion of the savings (or losses) generated by the coordination of care for Medicare fee-for-service (FFS) beneficiaries, within the FFS reimbursement structure. ACOs participating in MSSP generated Medicare savings of $429 million in 2015, largely through reductions in inpatient use.[4,5] Although ACO quality scores have improved over time, it is unknown whether these metrics translate into improved health outcomes for patients.[6]

Stroke treatment is an opportunity to improve the value of care due to the high cost as well as high mortality and morbidity rates among patients.[7] Although stroke mortality declined over the past decade, it remains the fifth leading cause of death globally, and about 800K people in the United States experience stroke annually.[8] Despite the high mortality rate, only about one-third of ischemic stroke decedents receive palliative care services as recommended by American Heart Association guidelines.[9-12] Although few MSSP quality metrics relate directly to the stroke population, the MSSP is expected to improve long-term health outcomes (e.g., reduce recurrent stroke and mortality) and reduce use of acute care services through health systems changes focused on discharge planning, care transitions, and care coordination, which may improve preventive therapies like medication persistence.[13-21] Since 2003, the Get With The Guidelines®–

Stroke (GWTG–Stroke) has enrolled 1,600 hospitals in their program promoting adherence to acute-care guidelines. The registry provides a rich inventory of patient clinical factors and hospital quality of care to facilitate assessment of the impact of ACOs on stroke care. Linkage to Medicare claims in FFS beneficiaries allows for capture of post-discharge healthcare use and outcomes.

The long-term goal of my research is to improve population health outcomes by informing payment strategies that will maximize value in health care. The goal of this study is to compare one-year outcomes for GWTG–Stroke patients assigned to an MSSP ACO or presenting at a hospital participating in an MSSP ACO to those meeting neither criterion over the 2010 to 2015 period. The main hypothesis is that MSSP ACO participation is associated with improved clinical and patient centered outcomes.

1.2 Study Purpose and Specific Aims

Aim #1: Evaluate the association of MSSP with acute care use following incident stroke and sources of variation within ACOs.

- *Hypothesis*: MSSP will be associated with reductions in rates of subsequent hospital admission and increases in discharge to home and days alive and out of hospital (DAOH) in the year after hospitalization for stroke.
- *Hypothesis*: Among MSSP ACOs, ACO structural characteristics (e.g., year of entry, experience, primary-care focused, specialty-care focused, and size), market characteristics (e.g., poverty rate and population size) and MSSP market penetration (> 30% vs. ≤ 30% of hospital discharges aligned with any MSSP ACO), and ACO care continuity (beneficiary assigned vs. not assigned to the same MSSP ACO in which the hospital participates) will be associated with usage.

Aim #2: Evaluate the association of MSSP with clinical outcomes following incident stroke.

- Hypothesis: Among Medicare FFS beneficiaries, MSSP will be associated with reduced hazard rate for subsequent hospital admission, recurrent stroke, and all-cause mortality within one year relative to non-MSSP.

Aim #3: Evaluate the association of MSSP with quality of care at the end of life.

- *Hypothesis*: MSSP will be associated with improved quality of care at the end of life measured by 1) increased hospice use among those with high mortality risk at discharge and 2) increased length of hospice use among hospice users in all care settings (e.g., stay less than 7 days, live discharge, and median days in hospice).

Given the rapid adoption of the ACO strategy nationally, it is essential that we understand the relationship between ACOs and health outcomes to improve the implementation of the ACO strategy. This is a novel analysis of the potential impacts of ACOs for stroke patients. These results will inform the direction of the Medicare ACO program and determine whether the current quality metrics and savings eligibility requirements are sufficient for impacting stroke outcomes.

1.3 Study Significance

The proposed research is significant because it evaluates the impact of a novel payment strategy on health outcomes and quality of care in the context of a costly disease with high rates of mortality and morbidity. Stroke is the fifth leading cause of death in the United States and is responsible for 17.2 billion in medical expenditures annually.[8,22] ACOs aim to achieve the triple aim of better outcomes and patient experience with lower costs, however it is unknown whether the MSSP quality metrics translate into improved health outcomes for stroke patients.[6] Despite the high mortality rate among stroke patients, services associated with high-quality end-of-life care, hospice, and palliative care are underused among stroke patients.[12,23] This study will

improve our understanding of how MSSP ACOs are impacting use, outcomes, and quality of end-of-life care following stroke.

1.4 Research Question and Hypotheses

The goal of this study is to compare one-year outcomes among two populations: 1) GWTG–Stroke patients assigned to an MSSP ACO or presenting at a hospital participating in an MSSP ACO, and 2) GWTG–Stroke patients with neither exposure over the period 2010 to 2015. My overall hypothesis was that MSSP participation would shift care to less intensive care settings following stroke without adversely impacting clinical outcomes. I tested these hypotheses using the following three aims:

Aim #1: Evaluate the association of MSSP with acute care use following incident stroke and sources of variation within ACOs.

Aim #2: Evaluate the association of MSSP with clinical outcomes following incident stroke.

Aim #3: Evaluate the association of MSSP with quality of care at the end of life.

Specifically, I hypothesized that MSSP will be associated with reduced acute health services use without negatively impacting clinical outcomes as well as improved quality of care at the end of life among patients meeting criteria for Limited Life Expectancy (LLE).

1.5 Conceptual Model

From 2003 to 2013, stroke deaths declined by 18% due in part to advances in stroke treatment as well as improved use of pharmacotherapy for primary and secondary prevention; however, 800,000 people in the United States are hospitalized for stroke each year with a one-year mortality rate over 30%.[8] The risk of stroke increases with age, and two-thirds of strokes occur in those age 65 or older.[8] Health services use remains high over the year following hospitalization for stroke, and post-acute care (PAC) is typically provided in skilled nursing

facilities (SNFs), inpatient rehabilitation facilities (IRFs), home health (HH) agencies, and/or outpatient (OP) rehabilitation settings.[24]

Medicare ACO models including Pioneer and MSSP have been marginally successful in reducing costs, primarily through reductions in acute care services, though performance is highly variable among ACOs.[5,25-31] Predecessors to the MSSP demonstrated moderate success in reducing acute care use (inpatient use, emergency department use, and readmission rates) as well as post-acute services (skilled nursing facilities and home health visits).[4] ACOs are expected to prevent hospital admissions and readmissions through preventive services (e.g., medication and lifestyle changes) and coordinated outpatient care.

ACOs are intended to achieve the triple aim of better outcomes and patient experience with lower costs, however it is unknown whether the MSSP quality metrics translate into improved health outcomes for patients.[6] Patients with stroke could potentially benefit from these care pathways due to the high risk of adverse outcomes (e.g., recurrent stroke and mortality).[32] Early ACOs were effective in reducing acute care service use among groups with cardiovascular disease, at high risk for hospitalization, and with prior hospitalization.[33] Reductions in acute care use may be due in part to improvements in care transitions, with greater use of physician visit within seven days of discharge from the hospital.[4] Prior studies have not found an association between ACO status and short-term outcomes (30-day mortality, in-hospital complications, readmissions, or inpatient length of stay) among hospitalized patients (cancer surgery or traumatic injury),[26,34] but the impact on longer term health outcomes is unclear.

Palliative care services, including use of the Medicare hospice benefit, have the potential to improve the quality of end-of-life care, yet these services are underused among stroke patients.[12,23] The American Heart Association recommends that all stroke patients should receive

palliative care early in the disease trajectory; however, only about one-third of ischemic stroke decedents receive this evidence-based service. [9-12] Palliative care is patient- and family-centered care that optimizes health-related quality of life by anticipating, preventing, and treating suffering. Use of palliative care via Medicare hospice benefit improves the quality of end-of-life care; however, these benefits may not be realized for the 1 in 3 hospice beneficiaries with hospice stay of less than seven days. [35-41]

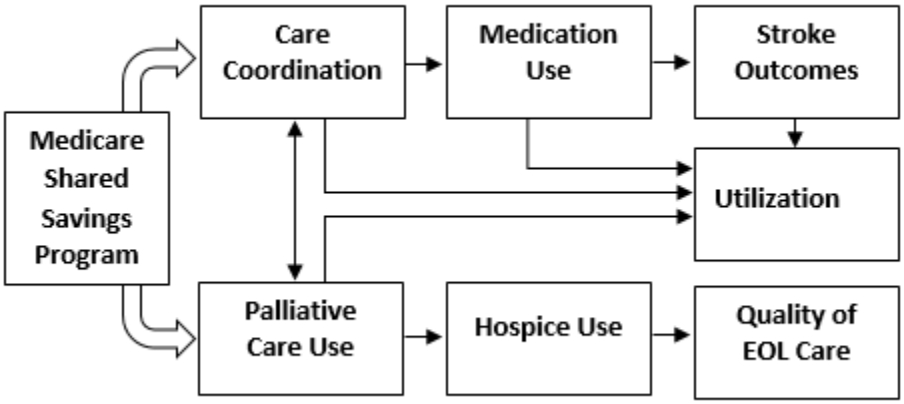


Figure 1. Causal pathways for the impact of the Medicare Shared Savings Program on outcomes for stroke patients.

Among stroke patients, ACOs are hypothesized to impact one-year health outcomes through improved care coordination, chronic disease management, non-medical social supports, and population management processes (Figure 1).[13-20,42] For example, patient-centered medical homes, one strategy used by ACOs to manage populations with multiple chronic comorbidities, is positively associated with initiation of oral anticoagulation therapies among patients with atrial fibrillation.[43] Among Medicare stroke patients, 30-day readmission rates range from 15% to 39%, with higher rates among patients with multiple chronic conditions. Furthermore, at least

10% of these readmissions were potentially preventable.[24,33,44] Hospital quality improvements (e.g., prescription of evidence-based medications at discharge and better care transitions at discharge) are expected to impact outcomes for all patients, regardless of whether the beneficiary is ACO-aligned.

MSSP has the potential to enhance the quality and value of end of life care by increasing use of palliative care, including hospice, as well as reducing stroke recurrence and mortality through care coordination. As in other alternative payment models, ACOs are expected to use palliative care, including hospice, as a strategy to improve symptom control and patient satisfaction, while reducing hospitalizations and ensuring value in services used.[45-52] Prior research has found ACOs are associated with decreased days in hospice in the general Medicare population.[4,5,27] This decrease could be driven by reductions in the proportion of stays longer than 180 days with the goal of reducing costs and improving appropriate use of the hospice benefit. If this is the case, it is possible to find a decrease in the average hospice days per capita and at the same time an increase in proportion of people using hospice at death and the median hospice stay. Other measures of appropriate hospice use such as the timing of hospice use relative to death have not been evaluated. This proposed study will extend the evaluation of MSSP ACOs to include impacts on long term health outcomes in a post-acute setting as well as on palliative care use for stroke patients.

CHAPTER 2. APPROACH

2.1 Overview and Rationale

The goal of this study is to compare one year outcomes among two populations: 1) GWTG–Stroke patients assigned to an MSSP ACO or presenting at a hospital participating in an MSSP ACO, and 2) GWTG–Stroke patients with neither exposure over the period 2010 to 2014. To achieve this objective, the study used hospitalization data from a national registry linked to Medicare FFS claims data in an observational study design. Hospitals choosing to participate in the MSSP are likely to be different from those that do not participate in ways that are correlated with the outcomes of interest. To control for this selection bias, each of the three aims used a difference-in-difference analysis to control for the differences between the MSSP hospitals and non-MSSP hospitals that remain fixed over the study period.

My overall hypothesis was that MSSP incentives for cost reduction would shift care to less intensive care settings following stroke without adversely impacting clinical outcomes. To determine the association of MSSP with acute care use, Aim 1 employed negative binomial models with a log link and offset to measure rates of discharge to home, hospital admission, and Days Alive and Out of the Hospital in the year following incident stroke. To determine the association of MSSP with clinical outcomes, Aim 2 used cox proportional hazards models with dependent variables of rehospitalization, recurrent stroke, and mortality in the year following incident stroke. To determine the association of MSSP with hospice use among patients with Limited Life Expectancy (LLE), Aim 3 used logistic regression models with outcomes of any hospice use within one year of incident stroke, comfort measures only within 2 weeks of

discharge, short stay in hospice (<7 days), and live discharge from hospice among hospice users. In addition, quantile regressions were used to evaluate shifts in the distribution of hospice days by MSSP status.

2.2 Innovation

This study will use both hospital- and beneficiary-level measures of MSSP exposure to improve the precision of the estimated effect. Specifically, MSSP hospitals are defined as hospitals participating in an ACO with an MSSP contract, and ACO-aligned beneficiaries are defined as beneficiaries assigned to an MSSP ACO using CMS claims-based algorithms.[53] Beneficiaries discharged from a hospital participating in MSSP may not be assigned to any MSSP ACO. In the evaluation of the effect of MSSP hospitals, the treated group includes patients receiving acute stroke care for incident stroke at an MSSP hospital, including patients not assigned to any ACO. In the evaluation of beneficiary alignment, the treated group includes beneficiaries assigned to any MSSP ACO in CMS MSSP beneficiary-level files, which identify beneficiaries who receive a plurality of their primary care from ACO providers based on allowable charges regardless of whether acute stroke care was received at an MSSP hospital.[1]

Thus, MSSP hospitals are expected to impact care for all patients regardless of beneficiary ACO alignment through inpatient care processes and discharge planning. However, models evaluating MSSP hospitals that do not also control for beneficiary ACO alignment may be biased through contamination of the control group if the patients who present at a control hospital are assigned to an ACO. As a result, estimate for MSSP hospitals may be biased toward the null and understate the association with outcomes. Likewise, failing to account for the MSSP

[1] In the patient-level definition for the MSSP program, CMS identifies beneficiaries who received at least one primary care service from a physician who is a member of an ACO and then employs a step-wise process to determine ACO assignment with the goal of attributing beneficiaries to an ACO if more care was received from that ACO (defined by allowed charges) than any other ACO or non-ACO providers. (42 CFR 425.402 - Basic assignment methodology.)

hospital effect on non-ACO patients during the inpatient stay could also result in attenuation bias for the estimated effect of beneficiary ACO-alignment. Up to 90% of beneficiaries receive care outside of the ACO, and 25% to 30% of ACO-aligned beneficiaries change from year to year.[5,33,54,55] Thus, this study improves on current evidence by accounting for both the hospital-level assignment and the patient-level assignment reducing misclassification and improving precision in estimating the effect of MSSP.

Second, existing studies of MSSP using claims data have limited controls for case mix and severity, which are critical adjustment factors for assessing variation in outcomes. The GWTG registry provides a rich set of clinical covariates and demographic data to reduce bias from unmeasured case mix variation that may occur in claims-only analyses. Among the key clinical covariates captured in GWTG–Stroke is severity of stroke on neurologic exam, one of the most important factors in predicting short- and long-term outcomes after discharge.[56] Furthermore, risk adjustment reduces bias in the evaluation of ACO characteristics associated with high impact on outcomes by controlling for case mix variation across ACO types.

Finally, I evaluated the use of comfort measures only (CMO) for a subgroup of patients prospectively identified during hospitalization by physicians and predictive measures as having Limited Life Expectancy. Studies of end-of-life care frequently retrospectively identify the population in need of palliative care using date of death, however in practice physicians can only be held accountable for improving the quality of end-of-life care for patients who can be identified prospectively. Using these novel data, this project will generate new knowledge about the role of MSSP in improving health outcomes and end-of-life care for patients hospitalized for stroke.

2.3 Data Sources

Hospitalization records from the GWTG registry for the study period (2010–2014) were linked to CMS denominator, MSSP, and inpatient and hospice claims files (2010–2015) using a validated algorithm (Hammill, 2009).[57] The GWTG–Stroke Program was developed by the American Heart Association/American Stroke Association (AHA/ASA) as a national stroke registry and performance improvement program. The primary goal was to improve the quality of care and outcomes for stroke and transient ischemic attacks by promoting consistent adherence to the latest scientific treatment guidelines. This national registry, which includes 5 million discharges since 2003 at 1,656 hospitals, is similar in clinical characteristics to the larger Medicare FFS population.[58] This high-quality data source has an average 90% retention of hospitals sites and over 96% reliability of measures.[59,60]

Participating hospitals submit hospitalization-level data on patient risk factors, diagnostic testing results, in-hospital and discharge treatments, adherence to acute and discharge performance measures, defect-free care measures (e.g., information on how well hospitals provided appropriate care for all patients), composite care measures (e.g., overall measures that reflect total care of patients), and in-hospital outcomes. In addition, hospital characteristics including ownership, stroke center status, teaching hospital status, number of beds, rural status, and Census region are available.

2.4 Sample Size and Power

Sample Identification

The sample included Medicare FFS patients hospitalized in a hospital participating in the GWTG–Stroke registry between January 2010 and December 2014 who are age 65 or older with a final diagnosis of ischemic stroke and linked to CMS claims. Exclusion criteria include prior stroke, admission year greater than discharge year, missing all prior medical history, or

registered at sites missing more than 25% of baseline data. To obtain longitudinal outcomes, we used a previously validated probabilistic matching technique to link in-hospital data from GWTG–Stroke to Medicare claims data.[57]

Linkage to CMS files used FFS claims and thus was only possible for Medicare FFS beneficiaries. To better understand the generalizability of findings to Medicare Advantage (MA) beneficiaries and FFS beneficiaries that did not link, I compared demographics, medical history, and clinical factors of eligible Medicare hospitalizations in the GWTG registry who successfully linked to CMS claims (N=352,318) with those 65 years and older but unable to link (N=222,818) (e.g., Medicare Advantage hospitalizations and Medicare FFS hospitalizations that failed to link with CMS) in Table 1. Standardized difference scores are used to compare baseline covariates between CMS linked and unlinked discharges. Unlike a t-test or Wilcoxon rank-sum test, standardized differences are independent of sample size because they express the average difference between means in standard deviation units.[61] Hospitalizations that fail to link are primarily Medicare Advantage patients that have no FFS claims to support the linkage process, however I am unable to identify FFS from Medicare Advantage (MA) patients in the absence of linkage to CMS files.

In this sample, FFS-linked patients were older with an average age of 80 compared to 78 among those that failed to link, which is consistent with national comparisons of Medicare Advantage and FFS patients (Table 1).[62] Other patient demographics, medical history, clinical measures, and hospital factors were not substantially different (standardized difference <0.2) between the two groups except for location in the West Census region (standardized difference =0.24). After excluding duplicates and patients not FFS at discharge (N= 24,124), my analytic cohort included 328,194 beneficiaries (Figure 2).

Table 1. Characteristics of Eligible Get With The Guidelines–Stroke Registry Discharges by Fee-For-Service Medicare Linkage Status (2010–2014)

	FFS Linked * N= 352,318		Medicare Advantage or failed to link to FFS N= 222,818		
Variable	*Mean*	*SD*	*Mean*	*SD*	*StDif*
Patient Characteristics					
Registry Patient Age median (25th-75th percentile)	80.0 (73-86)		78.0 (71-85)		0.19
Female	57.7%		54.3%		0.07
medicaid	7.1%		8.0%		0.05
private	38.0%		41.5%		0.01
Black	9.7%		13.3%		0.04
Hispanic	3.8%		8.2%		0.02
Hospitalization Characteristics					
Discharge to Home	39.2%		45.0%		0.12
Discharge to Skilled Nursing Facility	4.0%		3.3%		0.12
Discharge to Home Health	1.7%		1.6%		0.12
Discharge to Inpatient Rehabilitation Facility	4.4%		3.0%		0.12
Discharge to Hospice	6.2%		5.3%		0.00
Inpatient Death	5.5%		5.6%		0.04
Length of Stay	5.0	(4.6)	5.3	(5.9)	0.16
Mortality Risk Factors					
NIH Stroke Severity on Admission	7.4	(8.4)	7.0	(7.9)	0.05
CHA2DS2-VASc Score [D]	4.1	(1.9)	3.9	(1.3)	0.04
Historic: Modified Rankin Scale at Discharge	4.4	(0.8)	4.3	(1.9)	0.04
What was patient□ambulatory status at discharge?	2.7	(8.6)	2.7	(0.8)	0.09
GWTG Global Stroke Estimated Mortality Rate (Ischemic Stroke, SAH	6.4	(8.5)	5.7	(7.9)	0.08
Medical History					
Medical History - Prosthetic heart valve	1.6%		1.4%		0.08
Medical History - CAD/prior MI	30.5%		27.8%		0.02
Medical History - Carotid Stenosis	4.0%		3.7%		0.06
Medical History - Diabetes Mellitus	31.6%		34.0%		0.02
Medical History - PVD	5.4%		5.0%		0.05
Medical History - Hypertension	83.8%		84.2%		0.02
Medical History - Smoker	10.0%		12.2%		0.01
Medical History - Dyslipidemia	48.8%		49.2%		0.07
Medical History - HF	11.5%		10.0%		0.01
Medical History - Drugs/Alcohol Abuse	0.5%		2.6%		0.03
Medical History - Family History of Stroke	3.0%		3.1%		0.03
Medical History - HRT	0.2%		0.2%		0.16
Medical History - Migraine	0.5%		0.6%		0.00
Medical History - Obesity/Overweight	5.8%		7.0%		0.00
Medical History - Renal insufficiency - chronic (SCr>2.0)	3.7%		4.2%		0.01
Medical History - Sleep Apnea	0.5%		0.6%		0.05
Medical History - Depression	1.7%		2.0%		0.02

Table 1. (Continued)

	FFS Linked *		Medicare Advantage or failed to link to FFS		
Variable	*Mean*	*SD*	*Mean*	*SD*	*StDif*
Inpatient Clinical Measures					
Measurements: BMI	27.2	(6.8)	27.5	(6.8)	0.04
Measurements: Diastolic BP at Discharge	71.4	(12.4)	71.8	(12.4)	0.04
Measurements: Systolic BP at Discharge	137.7	(21.3)	137.3	(20.9)	0.02
Measurements: A1C (0-20), %	6.5	(1.5)	6.6	(1.6)	0.05
Measurements: Lipids - HDL (0-120), mg/dL	45.4	(14.6)	45.2	(14.5)	0.01
Measurements: Lipids - LDL (30-500), mg/dL	96.3	(37.5)	97.3	(37.7)	0.03
Measurements: Vital Signs - Heart Rate (30-200), bp	79.9	(18.1)	79.9	(18.2)	0.00
Measurements: INR (International normalized ratio	1.2	(0.6)	1.2	(0.6)	0.03
Measurements: Serum Creatinine (0-150), mg/dL	1.4	(4.9)	1.4	(4.6)	0.00
Dysphagia screening result	1.3	(0.5)	1.3	(0.5)	0.05
Hospital Characteristics					
SiteTrait: Rural Location [D]	5.6%		4%		10%
SiteTrait: Teaching Hospitals [D]	57.2%		59.5%		0.05
SiteTrait: Primary Stroke Center	100%		100.0%		0.00
SiteTrait: # of Beds in Hospital [D]	415.9		430.1		0.05
Northeast	26.0%		28.6%		0.06
Midwest	21.5%		16.6%		0.13
South	36.9%		29.5%		0.16
West	15.6%		25.3%		**0.24**

*Includes 24,124 observations that were not FFS at discharge but were FFS at some time during the year.

Limited Life Expectancy Subgroup

Patients with stroke have varied care trajectories depending on the severity of stroke, preferences, and health status. Many strokes are mild or moderate and post-stroke care is focused on rehabilitation and preventive measures. Patients with severe stroke or poor health status may have different goals for their care, particularly if they have limited life expectancy. For this study, beneficiaries meeting any one of the following criteria were identified as Limited Life Expectancy (LLE).

- National Institutes of Health Stroke Scale (NIHSS) score of ≥15, which indicates a high probability of death or severe disability[56]

- GWTG mortality risk (global or ischemic) prediction score > 0.15
- Contraindication for evidence based treatment due to provider reported limited life expectancy (*GS_Reasonnoantithrom_8, GS_rehabsvcs_5, GS_relexclusion_3, GS_whynoatrialmeds_5, GS_NOIVWARNING2_8*)

Additional LLE for Aims 1 and 2:

- Discharge to hospice (GWTG registry *dispositioni*).
- Registry reported comfort measures only received at any point during the index hospitalization. (*GS_Comfort Only* < 4)

The effect of MSSP is evaluated separately among the group meeting LLE criteria (20% of the linked cohort) and the other patients due to the substantial differences baseline hazards and care trajectories. Although these criteria are not validated or published prior is identified as LLE and the one-year mortality rate for the subgroup meeting at least one LLE criteria is 63% versus 18% in the rest of the sample.

Sample 1: Aims 1-2

Beneficiaries who linked to CMS FFS claims but were not FFS at the time of discharge were excluded (N=24,124). Other exclusions were patients who died during the index hospitalization (n=19,742), discharge disposition as Left Against Medical Advice (n=838), or missing Area Health Resource File (AHRF), race, or discharge disposition (n=1,881). Finally, patients meeting the criteria for LLE were excluded (N=54,128) because the care trajectories are expected to be much different in this subgroup than in the rest of the sample, resulting in a final sample of 251,605 (Figure 2).

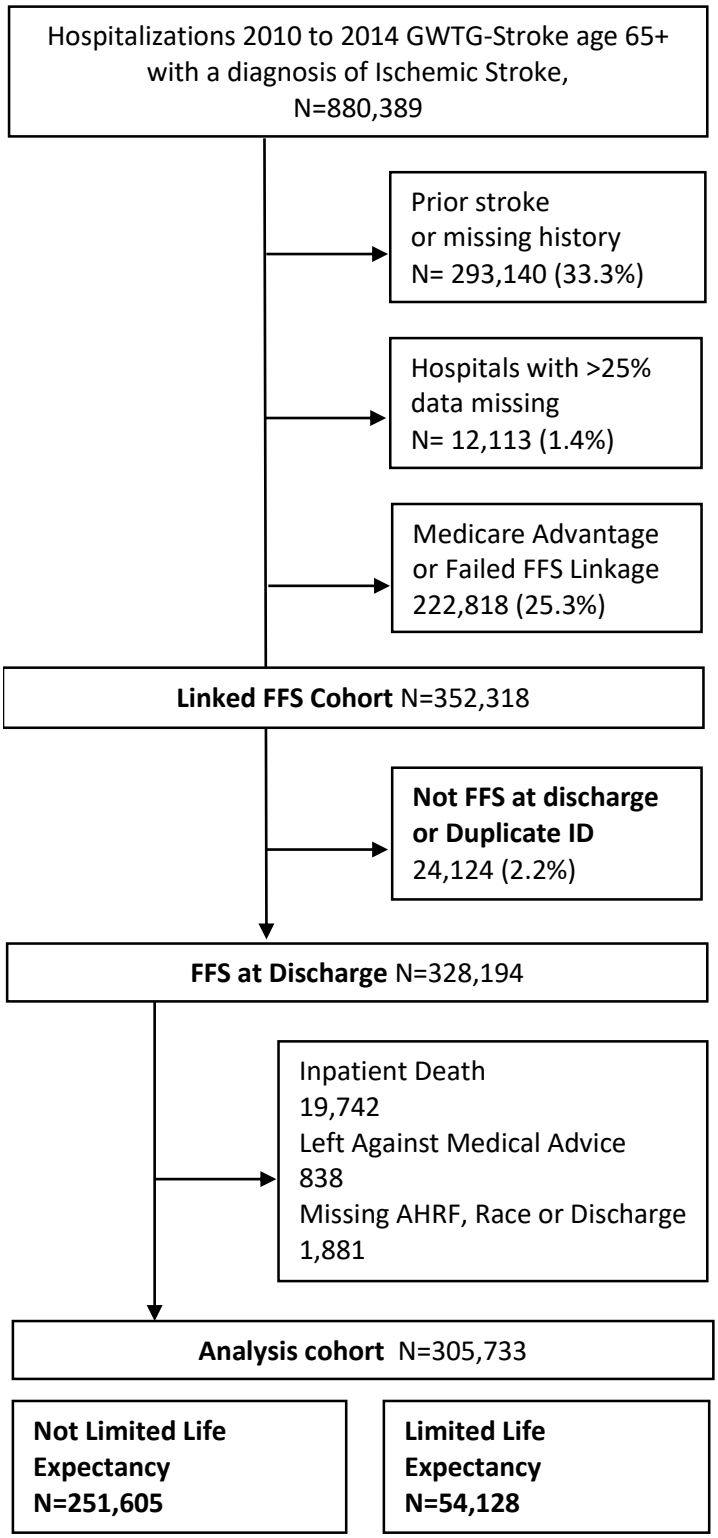


Figure 2. Cohort selection for clinical and use outcomes (Aims 1 and 2).

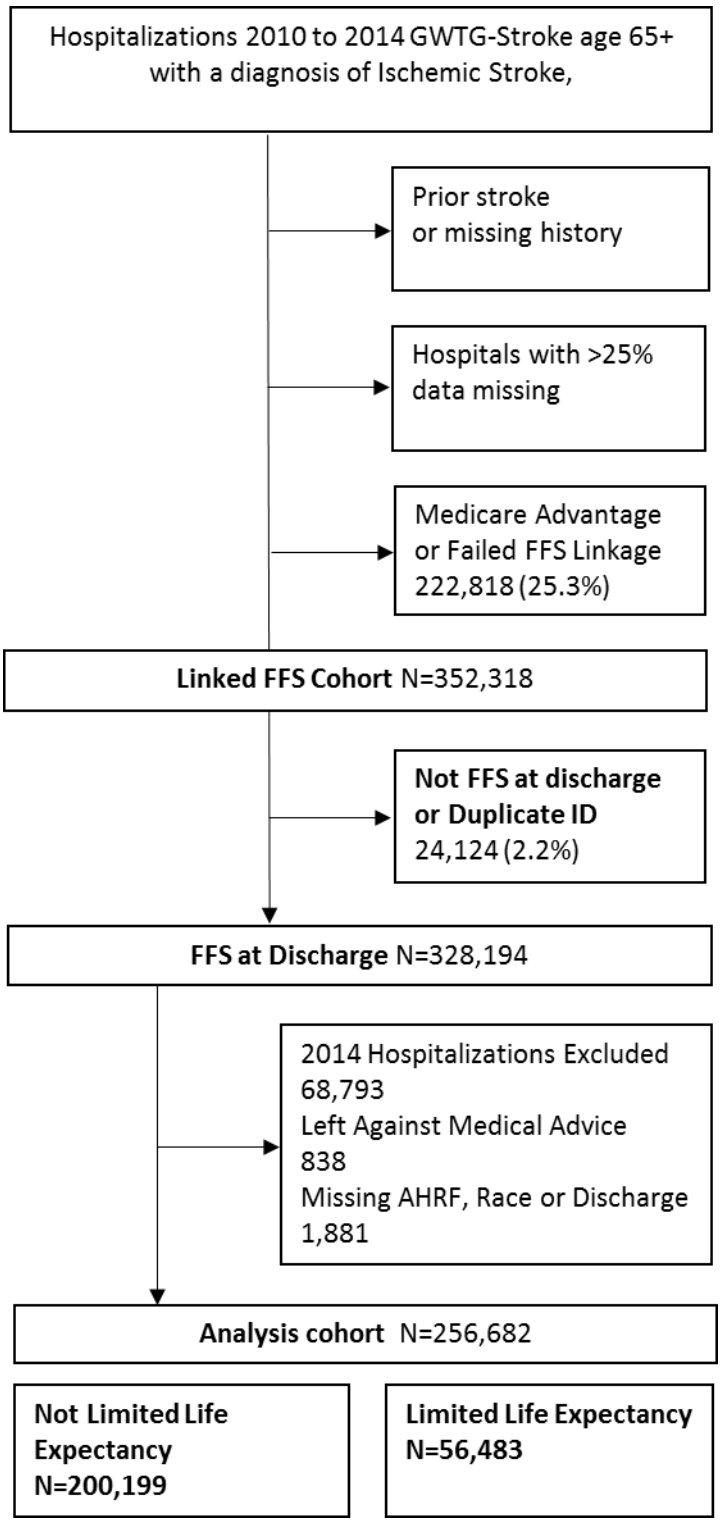


Figure 3. Cohort selection for palliative care and hospice outcomes (Aim 3).

Sample 2: Aim 3

Beneficiaries who linked to CMS claims but were not FFS at the time of discharge were excluded (N=24,124). Other exclusions included discharge disposition as Left Against Medical Advice (n=838), or missing AHRF, race, or discharge disposition (n=1,881). Finally, patients with index hospitalization in 2014 (n=68,793) were not included because one full year of follow-up in hospice claims was not available. Of 256,682 patients in the final sample, 56,483 were identified as Limited Life Expectancy (LLE) (Figure 3). Models included an interaction with the LLE indicator to test for effect heterogeneity within this subgroup.

Power

Power to detect differences in mortality is based on the following assumptions. Discharges from hospitals participating in MSSP (treated group) was expected to be 20% of the sample (actual proportion in analysis cohort was 19.2%), which is higher than the ACO distribution in the general population at that time because hospitals participating in GWTG are more likely to be located in urban areas where ACOs are more prevalent than the general population of hospitals. In the year following incident stroke, the baseline mortality rate was estimated to be at least 25% (actual mortality rate in analysis cohort was 29%),[63] and based on studies of similar payment programs, I expected a potential reduction in mortality rates of 1 percentage point [64,65] resulting in a hazard ratio between 0.96 and 0.97. Given a sample of at least 100,000 patients (actual analysis sample for the clinical outcomes is 251,605), this analysis had >80% power to detect a hazard ratio of at least 0.97 (Figure 4). The baseline rate of rehospitalization is over 0.60 and we expect a potential reduction of 5 to 10 percentage points; there is sufficient power given this sample size to detect the expected hazard ratio of 0.83–0.91. However, this analysis is not powered to detect a hazard ratio of lesser magnitude; this analysis

would have reduced power to detect the same hazard ratio for recurrent stroke, which has a one-year rate just under 10% in the analysis cohort.

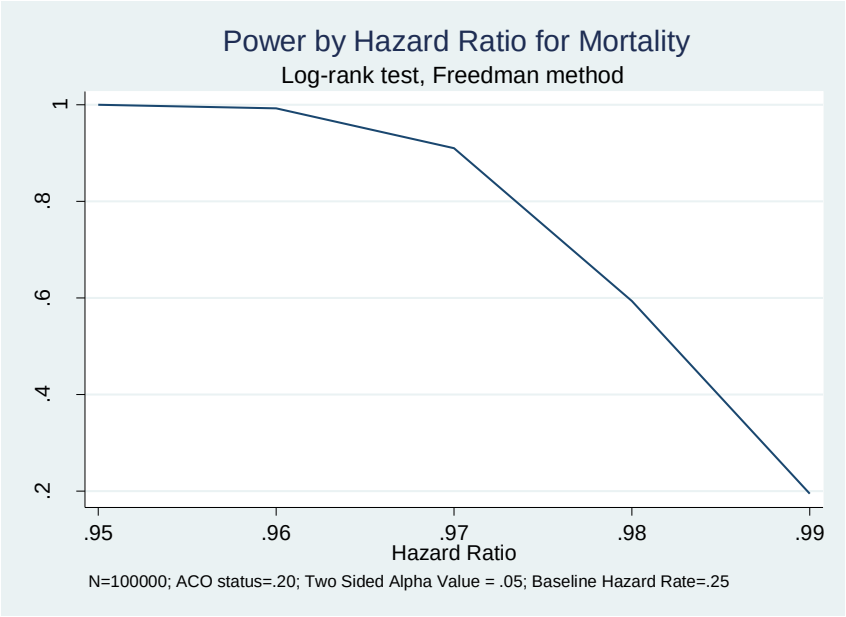


Figure 4. Power by hazard ratio for mortality.

2.5 Selection Bias

CMS MSSP Assignment Methodology

CMS uses a claims-based algorithm to assign beneficiaries to the ACO or non-ACO provider group providing the plurality of primary care, as defined by allowed charges. To be eligible for assignment to an ACO, beneficiaries must have at least one month of Part A and Part B enrollment and one evaluation and management claim delivered by a practitioner (identified by National Provider Identifier) participating in an ACO with an MSSP contract, including specialists, Critical Access Hospitals, Federally Qualified Health Centers, and Rural Health

Centers. A beneficiary is assigned to an ACO if the allowed charges for primary care services given to the beneficiary by primary care practitioners at the participating ACO are greater than the allowed charges for primary care services furnished by primary care practitioners in any other ACO and greater than the allowed charges for primary care services from the same types of providers in each non-ACO individual or group tax id number or CMS certification number.

In the MSSP beneficiary level files, CMS provides two types of assignment indicators using the same algorithm over different claims periods. The final assignment flag is based on an annual application of the algorithm using claims for services provided during the performance year with a 90-day run out to capture claims submitted up to 90 days following the end of the year. The preliminary assignment flag is based on quarterly application of the algorithm using claims for services provided over a rolling 365 day period (Figure 5).

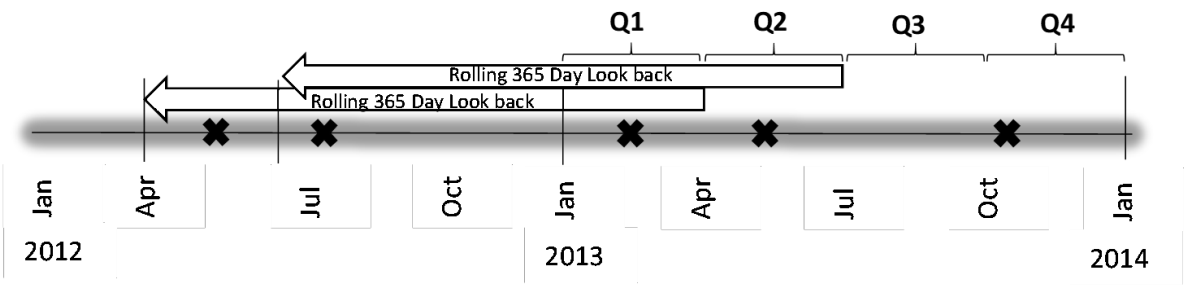


Figure 5. Illustration of the claims period used for the CMS preliminary Quarterly assignment of beneficiaries to MSSP relative to index hospitalization (indicated by X).

MSSP Immortal Time Bias

Like other claims-based algorithms, the MSSP assignment methodology relies on the accumulation of claims over time to increase sensitivity of the identification. As the time at risk increases, the prevalence of the MSSP assignment in the sample increases. This creates the potential for selection bias in the program related to time at risk, including survival time. As a result, the time period used in the assignment algorithm must be prior to the index date or start of follow-up to avoid immortal time bias.

Using the final assignment flag for the year of index hospitalization to identify MSSP beneficiaries would selectively exclude patients with short survival periods following stroke from the treatment group. In this scenario, at least part of the claims period used to identify MSSP beneficiaries would occur after the index date, causing patients who live longer following stroke have greater probability of being assigned to the treatment group. Those who do not survive long enough to be assigned default to the control group, resulting in biased estimates for the association between MSSP and outcomes correlated with survival.

Using the preliminary quarterly assignment flag in the quarter of index hospitalization to identify MSSP beneficiaries mitigates the bias for beneficiaries who survive at least 90 days following stroke because at least three quarters of the period used to identify MSSP would occur prior to the index date (Figure 6). To completely prevent the potential for this source of bias, the quarterly assignment flag for the quarter prior to discharge was used to identify MSSP beneficiaries. This ensures all beneficiaries survived to the end of the period used to identify the treatment group. Because the MSSP assignments is based on usage patterns over the year prior to the quarter of hospitalization, there is no guarantee that those patients identified as MSSP continue to use MSSP providers for their primary care during the follow-up period. Thus, this treatment definition is similar conceptually to an “intent to treat” analysis in which “treated”

patients adherence to and completion of the assigned treatment is not assured. I expect this potential misclassification of the treatment and control groups to bias my results toward the null.

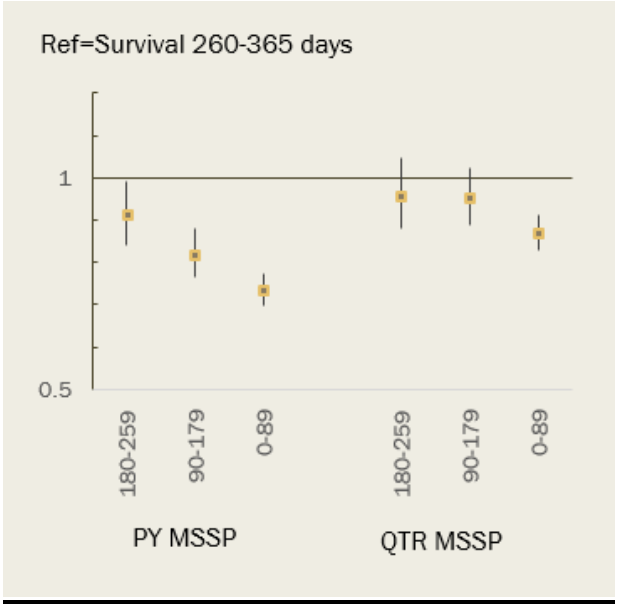


Figure 6. Odds ratios illustrating the association between beneficiary survival following stroke and assignment to the MSSP by 1) Retrospective Performance Year (PY) and 2) Prospective Quarterly (QTR) Assignment during quarter of discharge.

2.6 Key Variables and Measures

Exposures

ACO status for hospitals and beneficiaries was obtained from the CMS MSSP provider- and beneficiary-level files for performance years 2013 and 2014. For this analysis, I defined MSSP exposure using 1) hospital- or provider-level participation in MSSP and 2) CMS beneficiary assignment to MSSP. First, the hospital MSSP indicator is 1 when the patient is discharged from a hospital participating in an MSSP in any year during the study period as

determined by the CMS MSSP ACO provider-level files (MSSP performance years 2013 and 2014), and the hospital MSSP indicator is 0 for discharges at hospitals not participating in MSSP in any year during the study period; the time indicator for post-hospital MSSP implementation is 1 when the date of discharge is after the date of the hospital initiation of the MSSP contract (e.g., April 1, 2012; July 1, 2012; or January 1, 2013, for performance year 2013 and January 1, 2014, for performance year 2014) and before the most recent end date for the hospital participation in MSSP; otherwise the indicator for post implementation is 0.

Second, the indicator for ACO-aligned beneficiaries equals 1 when the CMS MSSP beneficiary-level files identified the patient as assigned to any MSSP ACO in the quarter prior to discharge using the preliminary quarterly assignment algorithm and 0 otherwise.[55]

These two types of exposure result in three treatment arms. The control group consists of 1) beneficiaries not assigned to an MSSP ACO in the quarter prior to discharge and 2) admitted to a hospital not participating in MSSP at the time of discharge. The effect of hospital participation in MSSP will be assessed among beneficiaries not assigned to MSSP but discharged from a hospital participating in MSSP at the time of discharge. Finally, the effect of beneficiary assignment to MSSP will be assessed among ACO-aligned beneficiaries controlling for hospital participation in MSSP.

Hospital

Each difference-in-difference analysis had two key variables (MSSP exposure and time period) whose interaction identifies the differential change in the MSSP treatment group in that time period relative to the baseline period. First, each hospital admission record was assigned to one of four time periods by discharge date, two time periods prior to the hospital's MSSP contract initiation date and two time periods post initiation (Figure 7).[32] MSSP contracts were

initiated in April 1, 2012; July 1, 2012; October 1, 2012, or January 1, 2013, for performance year one (PY) one or January 1, 2014, for PY2. Discharges prior to MSSP initiation were assigned to either the baseline period (more than 6 months prior to hospital MSSP initiation) or the run-up periods (within 6 months of hospital MSSP initiation). Post-MSSP discharges were assigned to either early MSSP (within 6 months of hospital MSSP initiation) or sustained MSSP (greater than 6 months after hospital MSSP initiation). The run-up period was intended to remove from the baseline referent period any impact from ACOs implementing care coordination process improvements and other quality improvement measures in anticipation of the official ACO start date. Furthermore, care coordination and other process improvements may take months to implement, so the greatest effects are expected for admissions occurring 6 months after initiation when the health systems have more fully implemented their quality improvements. However, models failed to detect a significant differential change for the MSSP group during the run up period, so the run up period was collapsed into the baseline period. Prior studies found decreases in total spending similar in magnitude in the first 6 months and first year.[32] Similarly, the two post periods were also collapsed for the main models presented due to lack of significantly different effects, however the differential impact of years of experience was presented as an effect moderator along with additional ACO characteristics.

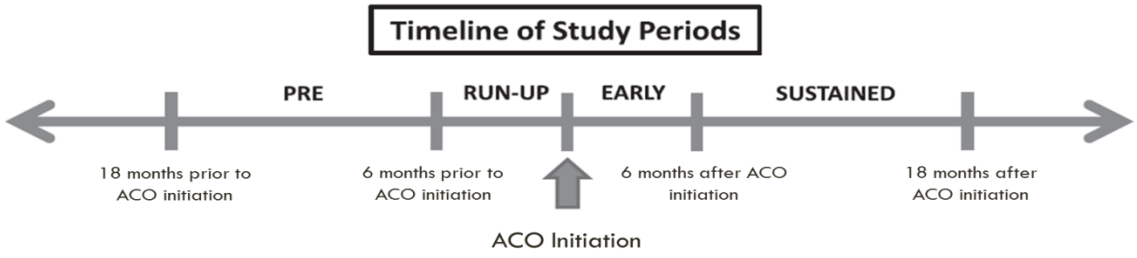


Figure 7. Time line of study periods.

Outcomes

Aim 1: Measures of acute care use in the year following discharge were 1) discharge to home, 2) Days Alive and Out of Hospital (DAOH), and 3) number of all-cause hospital admissions. Discharge to home was defined using the registry discharge disposition status. Patients not discharged to home were primarily discharged to inpatient rehabilitation facilities (IRF) or skilled nursing facilities (SNF) or other acute care facility (<5%). DAOH and number of hospital admissions were defined using Medicare inpatient claims and denominator files. Days alive and out of hospital was counted starting at hospital discharge for 365 days. DAOH is calculated as the number of days alive and on FFS (D_{ALIVE}) and spent outside of a hospital (D_{HOSP}), or an inpatient rehabilitation facility (D_{REHAB}). For any patient *i*, then:

$$HT_i = D_{ALIVE,\, i} - D_{HOSP,\, i} - D_{REHAB,\, i}$$

All use outcomes are conceptualized as a count per days of follow-up (or in the case of discharge to home count per discharge). Days of follow-up are censored at the first non-FFS day after discharge, one year of follow-up, death, or end of study period. The study end date was December 31, 2015, for all outcomes except recurrent stroke. The study end date for stroke was October 1, 2015, because of the transition to the *International Classification of Diseases, Tenth Revision* (ICD-10) and the lack of validation and comparison of the sensitivity and specificity of the definition of recurrent stroke in ICD-9 and ICD-10. In addition, inpatient days were not included in the days at risk for hospitalization so the offset for number of admissions was the log of DAOH.

Aim 2: Clinical outcomes in the year following discharge include 1) all-cause rehospitalization, 2) recurrent stroke, and 3) all-cause mortality. All-cause rehospitalization and recurrent stroke were defined using the Medicare inpatient claims files. A recurrent stroke was

identified by a principal diagnosis including ICD-9 codes 430 to 434 or 436 to 437 for a hospitalization or observation stay in the follow-up period.[66] Date of death was provided by the CMS beneficiary summary file. All-cause mortality was measured rather than stroke-specific because a high proportion of deaths (44%) following stroke are due to non-stroke causes.[67] In addition, ACOs are expected to impact mortality from all causes by coordinating care for patients with competing risks of death due to multiple comorbidities. Finally, the difficulty of ascertaining cause of death with high validity supported the use of all-cause mortality. All use outcomes were conceptualized as a count per days of follow-up (or in the case of discharge to home count per discharge). For mortality, days of follow-up were censored after one year of follow-up, death, or end of study period. For use outcomes defined by inpatient claims (rehospitalization and recurrent stroke), days of follow-up are censored at the first non-FFS day after discharge, death, 365 days after discharge, or end of study period. Although claims were available through December 31, 2015, the end of the study period was defined as October 1, 2015, for the outcome of recurrent stroke because of the transition to ICD-10 and the lack of validation and comparison of the sensitivity and specificity of the definition of recurrent stroke in ICD-9 and ICD-10.

Aim 3: Though there is no consensus about measures to define quality of care at the end of life, palliative care and hospice care have been associated with quality of care at the end of life.[35-39] Measures of quality of end-of-life care included use of comfort measures only or hospice as well as the timing of hospice enrollment among hospice users. Although the importance of palliative care concurrent with curative care is recognized, claims indicators (e.g., ICD-9 V-code modifier code V66.7) have low sensitivity.[68,69]

To capture outcomes more proximate to the hospitalization and expected to be impacted by hospital participation in MSSP, a binary composite outcome was defined as 1 when a patient received comfort measures only during the index hospitalization or enrolled in hospice within 2 weeks of discharge and 0 otherwise. To capture long-term outcomes expected to be impacted by the beneficiary assignment to MSSP, a binary outcome indicating hospice use within one year of admission was defined. Among hospice users, measures for the timing of hospice enrollment included enrollment within 7 days of death (binary), which is associated with the patient/family perception of being enrolled too late, and live discharge from hospice (binary), which has been used as a proxy for early enrollment, as well as total number of days in hospice (continuous).

Table 2. Summary Table

Outcome	Specification	Time from Discharge	Model
AIM 1 Exclusions:	*Inpatient Death (n=19,742) Left Against Medical Advice (n=838) Missing AHRF, Race or Discharge (n=1,881); Life Expectancy where LLE=discharge to hospice, comfort measures only, NIHSS>15, or GWTG Mortality Risk*		
Clinical Outcomes (N=251,605)			
Time to All-Cause Rehospitalization	Binary, Days follow up	1 year	Cox Proportional Hazards: with and without benefiary MSSP
Time to Recurrent Stroke	Binary, Days follow up	1 year	
Time to All Cause Mortality	Binary, Days follow up	1 year	
Acute Care Utilization (N= 251,605)			
Discharge to Home	Count (0-1)	Discharge	Negative Binomial with offset: with and without benefiary MSSP
Number of Hospital Admissions	Count (0-N)	1 year	
Days Alive and Out of Hospital	Count (0-365)	1 year	
AIM 2 Exclusions:	*2014 Hospitalizations Excluded (68,793) Left Against Medical Advice (n=838) Missing AHRF, Race or Discharge (n=1,881)*		
Quality of End of life Care (N= 256,682)			
Composite Comfort Care	Binary	2 weeks	Logistic regression; LLE as effect moderator;
Hospice Use	Binary	1 year	
Subgroup 1:	*Beneficiaries with any Hospice claim within 2 years of Discharge*		
Quality of End of life Care			
Days in Hospice (N= 72,115)	Continuous	Hospice duration	Quantile Regressions at 25/50/75 percentiles and GLM
Live Discharge from Hospice (N= 72,115)	Binary	Hospice duration	Logistic Regression
Subgroup 2:	*Beneficiaries with any Hospice claim within 2 years of Discharge and surviving at least 7 days after hospital admission;*		
Short Stay <7 days (n=63,956)	Binary	Hospice duration	Logistic Regression

ACO Characteristics as Moderators

- ACO cohort: start year performance year 2013 (includes 2012 start dates) or 2014
- Experience: number of years in MSSP
- Primary care focus: more than 10 primary care providers per 1000 beneficiaries
- Specialty focused: more than 10 specialists per 1000 beneficiaries
- Size: more than 20,000 beneficiaries.
- MSSP penetration: % of patients discharged from the hospital who are aligned with any MSSP ACO.
- Care continuity: beneficiary assigned to Hospital ACO

Covariates

Covariate Specifications

Patient control variables provided by GWTG include age, race, gender, Hispanic ethnicity, dual eligible status, pertinent medical history, and stroke severity as measured by the National Institutes of Health Stroke Scale (NIHSS) (linear, 0–42)[56] as well as health and ambulatory status at discharge. Specifically, models included five-year age categories as well as the interaction of sex and age group to allow for nonlinear effects of age.[21,32] Race/ethnicity (categorical) includes White, Black, Hispanic, Asian, Other. Binary indicators for risk factors (current smoker, hypertension, diabetes, myocardial infarction, heart failure, and atrial fibrillation) and Medicaid dual eligibility are used. Health status was measured by laboratory values (continuous) including body mass index, systolic blood pressure, diastolic blood pressure, heart rate, low density lipoprotein, high density lipoprotein, A1C, and the international normalized ratio. Ambulatory status was measured by a response of "unable to ambulate" (binary) and the Modified Rankin Scale (categorical, 0–5) for disability. Chronic Kidney disease

was identified by estimated creatinine clearance[70] less than 60 using: Glomerular Filtration Rate (GFR) = 175 × standardized $S_{cr}^{-1.154}$ × $age^{-0.203}$ × 1.212 [if black] × 0.742 [if female], where GFR is expressed as mL/min/1.73 m^2 of body surface area[41] and S_{cr} is expressed in mg/dL.

Hospital factors from the GWTG registry data include number of beds (continuous), annual stroke admisssions, Census region (categorical), and binary indicators for rural status, teaching hospital, and primary stroke center. Market factors obtained from the AHRF include continuous measures for county proportion over age 65; number of primary care physicians per 10,000 residents; proportion of households in poverty; total population (log); and number of hospice providers per 10,000 residents (Aim 3 only). Models also control for county Area Deprivation Index (log). Covariates were tested for collinearity (variance inflation factor >10) and as a result the GWTG mortality risk prediction score was excluded from the model.

Multiple Imputation Using Fully Conditional Specification

Excluding observations with missing covariate values (Complete Case Analysis) can introduce bias into estimates if these values are not missing completely at random. The potential for bias increases with the proportion missing, and NIHSS stroke severity score has the highest proportion missing (28%). In this cohort, missing NIHSS is correlated with hospital and patient characteristics, and the CCA approach could result in biased estimates. Multiple imputation of missing values relaxes the CCA assumption to require the values to be missing at random conditional on the other covariates. Because of the rich patient and hospital data available in the registry, this approach is likely to minimize the potential for bias by predicting the value of the missing variable using the other covariates available.

Exceptions to the use of multiple imputation include 1) observations missing patient-level variables with less than 1% of values (race and gender) missing are excluded (n<100); 2) missing single items in the medical history, where missing were imputed as “no” per GWTG standard

protocol because it is a common practice to only report in the affirmative during data collection; 3) observations missing hospital-level variables were excluded due to the lack of causal connections within the available information (n=0); and 4) missing market variables from the ARHF were imputed to the most recent year available and if none were available the observations were excluded (n<400).

Multiple imputation by fully conditional specification (FCS MI) is a powerful and statistically valid method for creating imputations in large data sets that include both categorical and continuous variables.[71] This method defines a separate conditional distribution of each imputed variable, and the user can define the variables on which to condition the distribution. For each imputed variable, I included all predictors that would be included in the main model (except hospital referral region fixed effects) as well as the clinical outcomes. Variables with skewed distributions (e.g., lab values) were log transformed for imputation and then exponentiated. Variables with limited range were imputed using logistic or ordinal logistic regression models. Numerical summaries were used to compare and confirm the similarity of the distributions between imputed values and observed values.

Main results were run in a single data set with missing values estimated using multiple imputation using the Fully Conditional Step method, which involved two phases: the preliminary filled-in phase followed by the imputation phase. First, missing values are randomly generated using a normal distribution to provide starting values for the conditional imputation. In the second stage, a statistical model unique to each variable was used to impute missing values for the imputed variable. In this study, the missing values for each variable were imputed using logistic regression for binary variables and linear regression for continuous variables. In addition to the covariates in the primary model, the dependent variables and auxiliary health status

variables (e.g., ambulatory status, dysphagia results, and mortality risk prediction score) were included in the imputation models.

This method introduces a source of error in the effect estimates due to the uncertainty involved in these imputed values into the analysis. To test the consistency of the estimates across multiple data sets with independently imputed values, I aggregated results of models estimated across five data sets with values computed in the same manner. Using five imputations resulted in a relative efficiency for imputed values around 99% and additional imputations would have little effect on the distributions. The combined estimated effect is the average of the estimates generated within in each imputed data set. The variance of that overall estimate is a function of variance within each imputed data set and the variance across the data sets. The between variation represented about 3% of the total variation in estimates and the combined estimated effects were similar in direction, magnitude, and significance to the estimates in the first imputation. For example, the coefficient for ACO-alignment is 0.0438 (CI=0.0167, 0.071) aggregated over five imputed datasets compared to .0408 (CI=0.0143, 0.0673) in the first imputed dataset. Because there was no meaningful difference, presented results are for the first imputation unless otherwise noted.

2.7 General Analytic Approach

I employed a difference-in-difference design to estimate the differential changes in the outcome among MSSP hospitals from the baseline to post MSSP relative to the concurrent change in the control group. Because the MSSP is a voluntary program, providers that decide to participate may be different from providers that do not in ways that impact outcomes. If providers that provide higher quality care are more likely to join ACOs and have better patient outcomes, then a model that does not control for the difference in quality would overestimate the effect of the program. The difference-in-difference method will reduce the potential for bias by

controlling for these unobserved differences between the treatment and control groups at baseline that do not change over time.[5,33,72]

A key assumption of this difference-in-differences analysis is that the difference in adjusted outcomes between the MSSP group and the non-MSSP group in the pre-contract period would have remained constant in the post-contract period in the absence of the MSSP. Although I was unable to demonstrate comparable trends given the few time periods prior to MSSP implementation, prior studies implementing this study design have found negligible difference in pre-trends.[21,27,29,32]

Evaluation of each outcome will use a difference-in-differences framework with the general formula:

$$L_{ijt} = f\left(a + X'b + u_j + v_t + \delta D_j^1 \cdot D_t^2 + \varepsilon_{ijt}\right), \qquad \text{(Eqn 1)}$$

where L is the outcome of individual I treated in hospital j at time t, f is the link function, X is the vector of case-mix covariates, u_j are HRR fixed effects, v_t are year and month fixed effects, D^1_j is a dummy variable taking the value 1 for hospitals that become part of the MSSP program, D^2_t represents dummy variables taking the value 1 for discharges after the hospital initiated the MSSP program, and ε is an individual-specific error term. The coefficient of interest is δ, the difference-in-differences estimator for the post MSSP relative to the baseline period. The result is interpreted as the population average effect of treatment on the treated group.

For each outcome, two models will be generated: 1) the hospital MSSP difference-in-difference model <u>without</u> controlling for beneficiary MSSP status; 2) the hospital difference-in-difference model <u>including</u> a dummy variable for beneficiary MSSP status. In the first model, δ represents the total effect of hospital MSSP, including the impact that occurs through the

outpatient care pathways for MSSP beneficiaries, relative to patients discharged from non-MSSP hospitals. In the second model, δ represents the net effect of MSSP hospitals through acute care pathways independent of the MSSP beneficiary effect though primary care pathways, relative to patients with neither MSSP hospital or MSSP beneficiary exposure (control). Variation in the effect by ACO characteristics was evaluated by adding an interaction with DD to the model not controlling for beneficiary MSSP status. In the model evaluating variation by ACO characteristics, Census division fixed effects were used as opposed to HRR fixed effects due to the limited number of HRRs (less than 1 in 4) with more than 1 ACO.

The wide variation in regional usage patterns may introduce bias into the estimate for the effect of MSSP because MSSP penetration varies geographically in ways that are correlated with outcomes. A hospital fixed effect would control for the unobserved hospital-level characteristics that impact use directly following discharge; inpatient and SNF use over the course of the year following discharge is expected to be driven by regional variation in physician practices patterns and cultural norms more so than hospital-level variation.[73]

Dartmouth Atlas defined 306 Hospital Referral Regions (HRRs) nationwide, built around cities where major cardiovascular and neurosurgeries can be performed. Like cardiovascular and neurosurgery, acute stroke care is highly specialized, and we expect the use patterns for this cohort of stroke patients to align well with the hospital referral regions. In addition, the variation within and between hospitals was assessed using the intraclass correlation coefficient (ICC). The lower the ICC score, the less likely that unmeasured hospital-specific effects influence the outcome estimates. Variation between hospitals explained less than 5% of the variation after controlling for Hospital Referral Region fixed effects. Thus, the statistical models include a HRR fixed effect to control for the unobserved, time-invariant factors within HRRs. Year and month

fixed effects are also included to account for changes over time and seasonal variation in outcomes within HRR.[74] The models evaluating variation in the effect by ACO characteristics include state fixed effects rather than HRR because only 20 out of 88 HRRs had more than one ACO, resulting in very little within HRR variation across ACOs.

Changes in the composition of the patient populations within treated and control groups over time may cause confounding if these changes are correlated with outcomes. Although prior analyses have not found meaningful differences between the ACO and non-ACO patient groups, potentially because patients are passively assigned to an ACO by CMS and are often unaware of their ACO status,[5,21,27,29,75] this potential bias is mitigated in this study by controlling for patient-level characteristics including age, race, and dual eligibility (which also help control for case mix and socioeconomic status) as well as county measures of socioeconomic status (e.g., poverty rates) and access (e.g., providers per capita).

The high mortality rate in this population raises two potential sources of bias in estimating the differential change for use outcomes. 1) differential loss of follow-up (non-informative censoring) and 2) the change in the intensity of acute care services as patients approach the end of life (informative censoring). Although the first concern is mitigated by incorporating time at risk into the model, informative censoring would require methods to decompose the total effect to assess the effect on rates of use independent of the effect due to informative censoring (mortality).[76] Differential mortality rates over the follow-up period were assessed visually using Kaplan Meier curves and statistically using a cox proportional hazards model. Because no evidence for a survival benefit was found, traditional methods were used to account for differential, non-informative censoring.

Aim #1: I hypothesize that MSSP participation will be associated with reductions in service use in the year following hospitalization for stroke. The primary measures of service use are discharge to home (registry), number of hospital admissions (IP claims), and Days Alive and Out of Hospital (DAOH) (IP claims) in the year following discharge. To test this hypothesis I used negative binomial models with log link to generate incidence rate ratios for each measure. For admissions and DAOH an offset (log [number of days follow-up/365]) was used to account for time at risk during the follow up period.

Aim #2: The objective of this aim is to evaluate the association of MSSP with health outcomes. I hypothesized that MSSP will be associated with reduced rate of rehospitalization, recurrent stroke and all-cause mortality within one year. To test this hypothesis, cox proportional hazards models were used to estimate a difference-in-difference for probability of survival at time t:

$$\lambda(t|X_{ij}) = \lambda_0(t)\, exp(X\beta) \qquad \text{(Eqn 3)}$$

In survival analyses, models were stratified by HRR to allow the baseline hazard rate to vary by HRR rather than a dummy variable approach, which can introduce bias.[77] In this approach, the fixed effects are absorbed into the unspecified function of time and fixed effect coefficients are not directly estimated. Proportional hazards assumptions were assessed visually using Kaplan Meier survival curves and plots of the log of negative log of the estimated survival functions by log of time as well as global tests for the models predicting each outcome and the assumption was not violated.

Aim #3: The objective of this aim was to test the association of MSSP with hospice use (across all settings) among patients with Limited Life Expectancy in the year following hospitalization. There are two specific hypotheses under this objective: 1) MSSP would be associated with increased hospice use (across all settings) among patients with Limited Life Expectancy in the year following hospitalization and 2) MSSP would be associated with increased length of use among hospice users.

To test the first hypothesis, I generated difference-in-difference estimates for the effect of ACO status on a binary indicator of hospice use, controlling for all covariates as in Aims 1 and 2 with the addition of number of hospice providers in the county (AHRF).

Logistic regression is preferred over survival analysis because earlier hospice initiation relative to hospitalization is not necessarily preferable—it is the timing relative to death that has been associated with quality. It is possible that ACOs improve hospice use through the pathway of improved survival, more time "at risk" of referral leads to greater referrals. This pathway still results in improved hospice use and quality of death, and thus the interpretation of the probability of hospice use is preferred over a hazard ratio. In addition to the logistic regression model within one year, I also used a negative binomial model with log link and offset to account for censoring to generate incidence rates ratios for hospice use over two years from hospitalization. The direction and significance of the estimates in both analyses were the same, so only the logistic results are presented.

Improved timing of hospice enrollment was measured by reductions in short stays (<7 days prior to death) and increased median hospice stay among hospice users who are deceased or discharged alive during the follow-up period. Patients surviving less than seven days from the index hospital admission date were excluded from the short stay model because they were not

eligible for the outcome. Logistic regression was used to estimate the average differential effect on the probability of a short stay, and quantile regression was used to estimate the distributional shifts associated with MSSP at the 25^{th}, 50^{th}, and 75^{th} percentiles. In addition, I used a generalized linear model to estimate the mean effect on hospice days.

For binary outcomes, a logit link will be applied to a difference-in-difference estimation:

$$Pr(Yi_{jt}=1|X_{ijt}) = exp(X\beta)/[1+exp(X\beta)] \quad \text{(Eqn 2)}$$

Average marginal effects were generated using the method of recycled predictions. Copies of the observed data were created for each group of interest: where both beneficiary MSSP and hospital MSSP are 0 (referent); where a hospital MSSP is 1 and beneficiary MSSP is 0; and where beneficiary MSSP is 1 and hospital MSSP is 0. Two sets of these groups were created where LLE=1 and LLE=0 for a total of six comparisons. The differential effects were generated by subtracting the predicted probability in the referent group from the treated groups among LLE and not-LLE for four treatment effects: hospital MSSP and beneficiary MSSP in LLE; hospital MSSP and beneficiary MSSP in not-LLE.

To generate confidence intervals around the predicted probabilities, I used bootstrapping to generate 100 random samples from the observed data. I ran the model within each sample to generate 100 sets of coefficients. I then used those coefficients to generate 100 predictions for each group and generated 95% confidence intervals from those distributions.

CHAPTER 3. IMPACT OF ACCOUNTABLE CARE ORGANIZATIONS ON USE, CARE, AND OUTCOMES: A SYSTEMATIC REVIEW

3.1 Introduction

Since 2010, at least 900 Accountable Care Organizations (ACOs) have formed over 1,300 payment contracts with public and commercial payers, managing care for 10% of the people in the U.S. population.[1,2] ACO growth (both organizations and contracts) is likely to continue given the Centers for Medicare & Medicaid Services (CMS) goal of making 50% of all payments value-based by 2018 and the growing support of commercial payers toward value-based payment arrangements.[78] Although Medicare is the largest single payer of ACO contracts, commercial ACO contracts collectively represent about 60% of the 32 million ACO patients nationwide as of March 2017.[79,80] Furthermore, 10 states had implemented Medicaid ACO programs as of January 2017, and at least 11 more are pursuing contracts.[81] Given this growth of ACOs in Medicare and non-Medicare settings, a better understanding of the systematic impacts on care and outcomes across payers is needed.

In the ACO model, providers across care settings voluntarily assume joint responsibility for the overall costs and quality of care of a defined population. However, financial performance is highly variable across ACOs, payer programs, and patient populations. The average savings generated by Medicare ACOs are nominal at best, with reductions of a $113 to $420 per beneficiary year in the Physician Group Provider Demonstration (PGPD) and 2012 Pioneer or Medicare Shared Savings Program (MSSP) cohorts, though no significant decrease was found among more recent cohorts or the Advance Payment ACOs.[5,27,32,75,82,83] Greater savings are observed among patients at high risk of inpatient use, exceeding $700 per beneficiary year

among cancer patients.[26,32,84] Of 287 ACOs with commercial contracts in 2014, only 12 published the financial outcomes, with 11 reporting reductions in spending between 2% and 12%; for example, the Alternative Quality Contract (AQC) and the Collaborative Accountable Care (CAC) model generated savings of 8.8% and 5.7%, respectively.[78,85] Despite nominal reductions in spending, the ACO strategy may increase total costs given the investment in technology and infrastructure required to implement the ACO contract and bonuses paid out to high performing groups.[27,86] For example, the Pioneer program resulted in a net savings of just 0.4% after accounting for bonus payments.[5]

Given the limited cost reduction to date, the ACO experiment may lose momentum if the promise to improve non-financial outcomes does not come to fruition. The current body of evidence supporting the consistency and generalizability of ACO impacts on care and outcomes across payers has not been evaluated. This study aims to fill that gap by systematically reviewing studies that assess the association of public and commercial ACOs with health services use, processes of care, and outcomes of care.

3.2 Conceptual Model

An ACO is conceptualized as a payer-provider partnership designed to improve quality of care and outcomes while reducing per capita costs for a defined population across the continuum of care.[87] ACO contracts align economic incentives with these goals to promote coordination of care, population health management, and care management programs (Figure 8). The implementation and effectiveness of these innovations will vary across ACOs due to provider group characteristics, including provider participation and governance structure, IT infrastructure and patient population, and contract incentives.[88,89]

By implementing care coordination strategies, ACOs may improve care transitions and reduce waste or duplication of services across the care continuum;[90,91] examples of potential

interventions ACOs may implement include improvements to hospital discharge planning and medication reconciliation.[92,93] ACOs build these interventions on a foundation of advanced health information technology to proactively manage the health of their patient population and increase provider and beneficiary engagement.[94-96] In addition, ACOs shift care from hospitals to low-cost settings by creating integrated clinical teams for complex patients that focus on prevention, disease management, and self-care as well as behavioral or social determinants of health (McClellan et al., 2014).[97,98] Through the systematic adoption of patient-centered medical homes, the chronic care model, and other evidence-based care practices.[99-101] ACOs are expected to reduce use of low-value services (e.g., diagnostic tests and imaging) and increase use of high-value services (e.g., preventive care, medication management, and palliative care). As a result of this systematic reorganization of care processes, ACOs are hypothesized to improve quality of care as well as population health outcomes while reducing costs through reduced inpatient use.

In addition to variation in ACO group characteristics, variation in the payer contracts (e.g., quality measurement and financial incentives) may motivate different health system innovations to improve health information technology and care processes. ACO contract components include financial accountability, quality measurement, and population health data sharing.[102-104] First, ACO programs transfer some degree of risk for the cost of care for a defined population to a provider group. Although over half of private contracts include some form of downside risk, most Medicare ACOs participate in shared savings only tracks.[105,106] Second, CMS prescribes quality metrics for Medicare ACOs, but non-Medicare contracts vary in the measures used to evaluate care quality.[107] Shared savings or bonus payments are generally contingent on achievement thresholds, growth rates, or benchmark comparisons.[105] Third, to improve population health, incentives are often linked to appropriate investments in

infrastructure and quality reporting. These three principles rely heavily on integrated information technology systems to share data both across providers within the ACO as well as between the payer and the ACO.[88,108]

The value proposition of ACOs has two components: reducing costs and improving processes of care and outcomes. Despite the common goals, ACO contracts are inherently heterogeneous in the degree of risk, quality metrics reported, and level of support for population health. This review acknowledges the heterogeneity across payer programs and definition of an ACO for this study was intentionally inclusive to compare the quality of evidence for use, processes, and outcomes across payers.

3.3 Methods

Search Strategy

We performed an electronic search of PubMed from January 1, 2010, to November 5, 2016, for U.S. studies that reported the effect of ACOs on use, processes of care, and outcomes. We used combinations of search terms for accountable care, Medicare Shared Savings, physician group, and Pioneer ACO to obtain an initial list of eligible articles as follows:

"accountable care" OR "MSSP" OR "Medicare Shared Savings" OR "Physician Group" OR "Pioneer ACO" AND (("2010/01/01"[PDat] : "2016/10/06"[PDat]))

Published abstracts of all articles identified in the search were reviewed to determine which ones reported empirical findings related to the ACO model. We focused on studies that explicitly assessed non-financial impacts of payer contracts with provider-led ACOs. As we selected primary documents or review articles, we used snowballing to identify related articles. Following the formal search, we added newly released articles and CMS evaluations that met the inclusion criteria through April 1, 2017.

Study Selection

We included articles if they were: 1) original reports or systematic reviews of empirical results and 2) the author(s) assessed a relationship between ACOs and health services use, processes of care, or outcomes of care. Because the intention is to evaluate payment strategies in the context of the United States, international studies were excluded. Each article was reviewed independently by two reviewers (BGK and SBS) for inclusion criteria and quality. The two reviewers then discussed discrepancies in selection and made decisions by consensus. For the purposes of this review, an ACO was defined as a payer-provider contract in which: (1) the financial incentives target networks of providers who assume responsibility for cost and quality across the spectrum of patient care; (2) quality benchmarks are required to be met to receive the incentives; and (3) the financial incentives increase with efficiency across the patient population, as demonstrated in global budget or shared savings programs. This broad definition was used to incorporate the effects of programs that preceded the ACO terminology. Assessments of provider strategies for quality improvement within ACOs were excluded, as were pay-for-performance programs that do not target systems of providers or tie incentives to global efficiency. Articles with decision science models were excluded because they are designed to determine potential population impacts given what is known about efficacy rather than evaluate efficacy.

Data Extraction and Synthesis

Two reviewers (BGK and SBS) assessed the quality of each study using the Newcastle–Ottawa Quality assessment scale for cohort studies independently. For scores that did not match, the reviewers came to a consensus after debate. Although all studies have limitations, studies were ranked high quality if they met the highest criteria for selection, comparability of controls, and outcome assessment (nine stars). Studies with one weakness identified in any of these categories are described as moderate quality, and those with more than one weakness are

described as low quality. Due to wide variation in ACO programs and outcome measures, results of studies are synthesized narratively as well as in a table by outcome (multiple measures of similar outcomes are combined for simplicity). Although the synthesis focused on quantitative results, qualitative studies were also summarized.

3.4 Results

Of the 1,890 total articles collected, 1,292 were not original research (e.g., interviews, commentaries, industry strategic analyses, responses to articles, case studies, final rule publications, and policy analysis), 489 did not study an ACO as the primary intervention, 69 did not assess non-financial outcomes, and two were duplicates (Figure 9). In addition to the 38 included PubMed articles, 8 studies were identified from other sources, including four federally funded evaluations.

Among the 42 articles identified (Table 3), studies of Medicare (N=24) programs included the Physician Group Practice Demonstration (PGPD), the Pioneer ACO program, Medicare Shared Savings Program (MSSP), and the Advance Payment Model; studies of Medicaid (N=5) programs included New York, Minnesota, Ohio, Oregon, and Colorado ACOs; studies of commercial programs or all-payer ACOs (N=13, one of which was a Medicare Advantage program—Aetna), the Blue Cross Blue Shield–Massachussetts Alternative Quality Contract (AQC), and the Cigna Collaborative Accountable Care (CCAC) model (Table 4). No literature review of this research question was identified.

Most (27) of the included studies used 2 to 5 years of post-intervention data, while 15 reported results after one year or less. Studies primarily used claims-based data sources and payer-tracked quality metrics, resulting in large sample sizes but limited measures of detailed patient and clinical factors. One study used institutional trauma registries.[26] Special subgroups

studied included the elderly, pediatric, mental and behavioral health users, cancer, clinically vulnerable, tobacco users, and low income groups.

Quality of Evidence

All studies were retrospective and observational due to the inability to randomize ACO assignment. The quality of study design was assessed by the Newcastle Ottawa Quality assessment scale. Studies using a pre-post design with a control group were rated moderate or high quality based on the level of adjustment for covariates. The 24 studies of ACOs participating in Medicare programs had an average quality score of 8 stars. The 18 studies of non-Medicare ACO programs had an average quality score of 6.8 stars. Statistically significant effects relative to a control group are summarized from 27 peer reviewed studies and 4 federally funded evaluations reporting (Table 5), and studies with 8+ star quality rating are prioritized in the narrative.

Use

Among studies evaluating effects of ACO participation on use, outcomes included inpatient use (inpatient days, hospital readmissions, intensive care unit or emergency department use), outpatient use (primary care visits, follow-up visits, physician services), post-acute or hospice care, and drug use.

Medicare: Medicare ACO programs including PGPD, Pioneer, and MSSP were consistently associated with reduced inpatient use and emergency department use, however there was no evidence of a difference among subgroups of mental health users or cancer patients.[5,25,27,32-34,75,82,84] The 2012 cohort of ACOs participating in MSSP had reduced acute inpatient care and discharges to facilities other than home, though these findings were not statistically significant within the first year of performance for the 2013 and 2014 cohorts.[109] The PGPD was associated with reductions in readmissions, however the MSSP was not associated

with reductions in 30-day hospital readmissions except among patients discharged to a skilled nursing facility (SNF).[82,110] MSSP ACOs reduced preventable admissions for Asthma/Chronic Obstructive Pulmonary Disorder.[27] The PGPD reduced intensive care unit (ICU) use among cancer patients, but the Pioneer program was not associated with a reduction in ICU use in a small sample of patients hospitalized for trauma.[26,84]

No evidence was found for a reduction of discretionary cardiovascular imaging and procedures as an indicator of low value service use in the PGPD.[31] Although multiple studies of the Pioneer program reported reductions in physician procedures, imaging, and other indicators of low-value care, there was no differential change in low-value service use among any of the MSSP cohorts.[5,26,27,29] An evaluation of the Advance Payment Model found that imaging, tests, and procedures increased from baseline relative to comparison markets.[83]

The most thorough study of the Pioneer program found significant effects on outpatient care including reductions in primary care visits, post-acute care (SNF, home health), and hospice use and increased follow-up visits within seven days of hospital discharge, an indicator of care coordination.[5] For MSSP, the sole study evaluating the impact on outpatient care patterns found no association with mental health–related outpatient or follow-up visits.[25] The 2012 MSSP ACO cohort was associated with reduced length of SNF stays, though these findings were not significant within the first year of performance for the 2013 and 2014 cohorts.[109] Among cancer patients, PGPD reduced hospice use and led to a decrease in mean hospice days per hospice user.[84] The Pioneer program did not significantly affect total prescriptions Medicare Part D filled or percent of claims for brand-name drugs, and no studies evaluating PGPD or MSSP and part D use were identified.[111]

Non-Medicare: The New York Medicaid program was associated with reduced emergency department use, rehospitalization, and readmissions within 90 days.[112] Furthermore, duration of attribution to an ACO was associated with greater reductions in 30-day readmissions and inpatient days among pediatric Medicaid patients, though emergency department and pharmaceutical use increased with duration.[55,113] The AQC was not associated with significant changes in inpatient or primary care among mental and behavioral health users, but it was associated with increased number of medication management visits and reduced probability of substance use disorder (SUD) medication use within a low-risk subgroup.[114,115]

Processes of Care

Among the studies assessing processes of care, primary outcome measures included Healthcare Effectiveness Data and Information Set (HEDIS) standards (chronic disease management, adult preventive care, and identification and treatment of behavioral and mental health disorders).

Medicare: In PGPD, care quality improved significantly in 6 of 7 quality indicators including diabetes management, hypertension management, coronary artery disease prevention, and cancer prevention.[33,75] In Pioneer ACOs, diabetes management improved by 0.8 percentage points, though there was no significant change in mammography screening in the first year.[116] No evidence of improvement in screening mammography, Diabetes Prevention Services, or LDL testing was reported within one year of MSSP implementation relative to controls.[27] There was evidence of a significant reduction in the prevalence of mental health disorders among Pioneer ACOs, though this difference was not found in MSSP ACOs.[25] The evaluation of Advance Payment ACOs found no consistent improvements in quality during the evaluation period.[83]

Non-Medicare: After one year, AQC was associated with an increase of 2.6 percentage points in the proportion of eligible enrollees for whom quality thresholds for chronic care

management were met and an increase of 0.7 percentage points in the proportion of eligible enrollees for whom pediatric care thresholds were met.[117] After two years, chronic disease management improved 3.7 percentage points ($p<0.001$); pediatric care improved 1.3 (1.8 among high need) percentage points, and adult preventive care improved 0.3 percentage points.[118,119] The quality of care for children in Partners for Kids Medicaid program improved significantly ($P < .05$) on five quality measures (including two composite measures) and declined significantly on three measures.[120]

After the first year of implementation of the Cigna collaborative care model, providers reported no change in five quality of care measures.[121] Over a period of three years, AQC was associated with improvement in three of five performance measures studied (nephropathy monitoring, LDL screening, and retinal exam, among individuals with diabetes), however this effect was not observed among the group of mental health service users.[114] Identification and treatment initiation for SUD improved among a low-risk subgroup, though these effects were not significant among all SUD users.[115] Of five preventive measures, only probability of cholesterol testing evidenced a spillover effect on the Medicare population.[122]

Outcomes of Care

Seven studies assessed either patient satisfaction or clinical outcomes in Medicare ACOs, but no study evaluated these outcomes in non-Medicare ACOs. For MSSP and Pioneer, overall ratings of care reported by clinically complex ACO patients improved significantly as compared with similarly complex patients in the control group.[123] Medicare beneficiaries assigned to Pioneer ACOs reported higher mean scores for timely care and for clinician communication relative to both non-ACO FFS and Medicare advantage beneficiaries, resulting in an increase in performance from the 86^{th} to 98^{th} percentile.[5]

Four studies assessed the impact of Medicare ACO programs on clinical outcomes including mortality. Among cancer patients, PGPD was associated with a significant reduction in patient mortality of 0.65 percentage points over five years, which is equivalent to a 5.6% reduction in mortality risk.[84] In a nationally representative sample, the MSSP and Advanced Payment programs had no significant impact on mortality in the early years.[83,109] Furthermore, no evidence of an association was found between MSSP and short-term clinical outcomes including 30-day mortality, inpatient mortality, and surgical complications among cancer patients.[34]

3.5 Discussion

In this review, the evidence for the impact of ACOs on health service use, processes, and outcomes of care is mixed, however no evidence indicates that the incentives for cost reduction in ACOs resulted in negative impacts on processes or outcomes of care. The most consistent outcomes associated with Medicare ACOs are reduced inpatient and ED use as well as improved measures of adult preventive care and chronic disease management. Non-Medicare ACOs also found some evidence of improvement in care quality metrics— for example, AQC was associated with improved quality metrics (e.g., mental health, pediatric care, and chronic disease management) and a pediatric Medicaid program Partners for Kids was associated with improvement on composite quality measures, though the generalizability of findings for single-state programs is unclear. The seven studies evaluating patient experience or clinical outcomes of care showed no evidence that ACOs worsen outcomes of care, but only four studies assessed any clinical outcomes, and those that did included only Medicare patients.

This review highlights the need for high-quality evaluation of non-Medicare ACOs because variation in quality measurement may cause variation in the impact of ACOs. Commercial and Medicaid payers may choose to align their performance measures with

Medicare, but there is not a required standard set of metrics. Mandating quality metrics may stifle the motivation of physicians and administrators who do not believe in their validity, subsequently harming their overall performance.[124] In addition, financial and quality data for commercial ACOs are proprietary whereas Medicare data are publicly available. As a result, little is known about commercial ACOs quality measurement and performance outside of the AQC. Although Medicare ACOs have not adversely impacted measured process-of-care outcomes, the increased focus on measureable aspects of care may reduce the time providers spend on unmeasured aspects resulting in unintended impacts on care and outcomes.

These results suggest that more time may be needed to determine the impact of ACOs on patient outcomes. Improvements in processes of care were consistently demonstrated in studies of PGPD and Pioneer Medicare payment programs, however nearly 75% of the original Pioneer ACOs later shifted to MSSP tracks with reduced downside risk. As a result, the Pioneer ACOs not demonstrating high performance may not be represented in the literature. The Pioneer track attracted ACOs with greater experience in managing care while the MSSP tracks allowed nascent ACOs to gradually assume risk, and these systems may require years to fully implement care coordination strategies and affect change. The relative inexperience of the MSSP ACOs may explain why the early impacts on processes and outcomes measures are ambiguous. Furthermore, previous CMS programs like the Medicare Premier Hospital Quality Incentive Demonstration produced positive results at first only for top performers, but regression to the mean led to null results in the long term.[125] Finally, fee-for-service still accounts for the vast majority of reimbursement within Medicare ACOs, which may preclude ACOs from maximizing the benefits of less lucrative interventions, like behavioral health.[96,124]

As ACO payment programs further shift risk for the cost of care to provider groups, the impact on health outcomes should continue to be monitored.[104] Shifting risk to providers has the potential to create tension between the incentives to control costs and the provision of the highest quality care for each patient. In the MSSP, ACOs initially share in the savings generated by efficiencies in care (Track 1), and then graduate to tracks with higher levels of risk. Although a limited-risk strategy was successful in attracting provider groups, greater risk sharing may produce more substantial changes in processes and outcomes of care. The number of Medicare ACO contracts with downside risk is increasing, with 10% of Medicare ACOs assuming some level of downside risk in 2017.

These early results are valuable in predicting whether the current ACO movement may stagnate due to a lack of progress toward the triple aim of improving care for the individual, population health, and cost control.[126-130] Prior to the emergence of ACOs, health maintenance organizations (HMO) and pay-for-performance (P4P) programs were hailed as the solution to the U.S. crises of escalating costs and declining health outcomes, but they fell short. The finding that ACOs do not reduce and may even improve some measures of patient satisfaction and perceived quality of care suggests that ACOs have not prompted the patient frustration associated with the HMO model, potentially due to the preservation of patient choice in providers in the ACO model, among other differences.[131] Similar to ACOs, P4P programs have been associated with small positive effects on the process measures targeted, however neither model has demonstrated consistent effects on health outcomes.[72,132-135] To improve population health and outcomes, ACO programs may need to incentivize measures of quality that are more closely tied to outcomes.

The conclusions that can be drawn from this review are modest. No prospective trials have evaluated ACOs, and we were unable to synthesize the results of observational studies into

a meta-analysis due to the differences between studies in the payer programs, populations, and outcome measures evaluated. Unpublished sources were only searched through references of published articles. As a result, this review may be affected by negative publication bias. However, the relevancy of this topic to national health policy is likely to minimize the impact of this bias, as evidenced by the proportion and number of null findings published. Due to our intentional focus within the U.S. healthcare system, our search was limited to PubMed, the primary database for high-quality, peer-reviewed evaluations of U.S. healthcare policies and programs. This decision may have resulted in fewer studies than a search of multiple databases. Finally, looking at outcomes alone misses important information regarding what it takes to produce those outcomes. Evaluating the specific mechanisms is outside the scope of our review, and future work to synthesize existing evidence and identify optimal mechanisms is needed.

The evidence for the effect of ACOs on care processes and outcomes is mixed, potentially due to the variability in contract incentives and outcome measures, but the incentives for efficiency within ACO contracts have not negatively impacted common care quality measures or patient satisfaction. Current trends in ACO contracts including increasing risk for provider groups and provider experience may magnify any impacts of ACOs on care processes and outcomes over time. Further studies are warranted to assess the downstream impacts of ACOs and other alternative payment strategies.

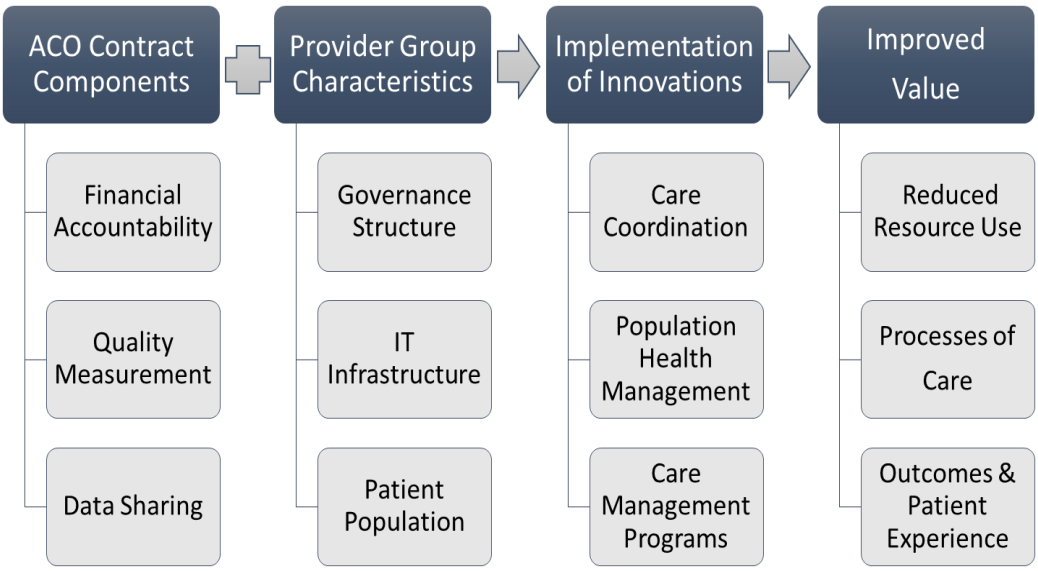


Figure 8. Conceptual model describing Accountable Care Organizations' impact on outcomes.

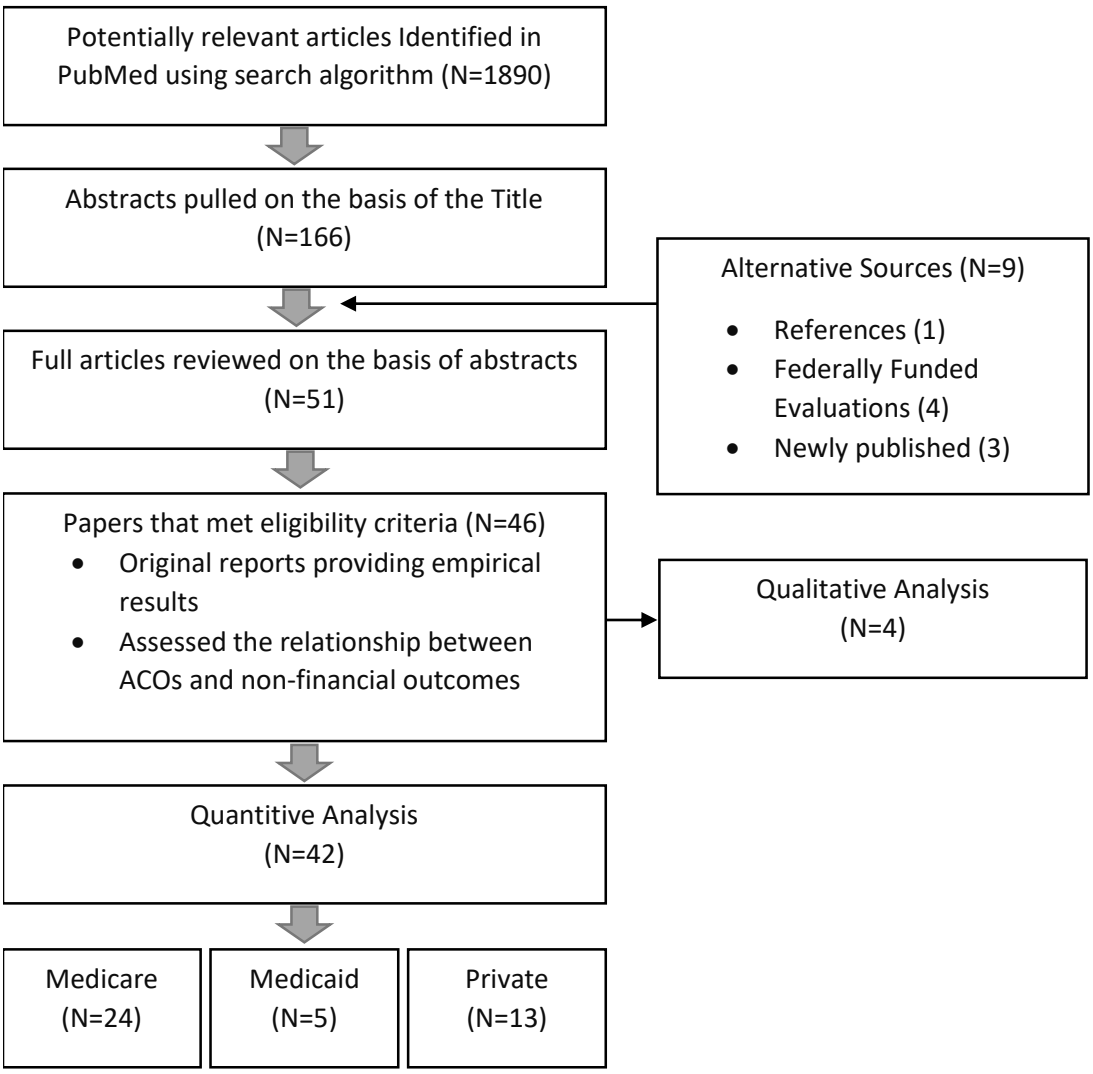


Figure 9. Flow chart describing article selection process and results.

Table 3. Summary of Articles and Reports Assessing Outcomes Associated with Accountable Care Organizations

New ID	Year	First Author	Payer Program	Follow up Time	Quality Score†
Quantitative Analyses					
Peer-reviewed publications, control group					
1	2011	Song Z	Alternative Quality Contract	1 Year	7
2	2012	Claffey TF	Aetna Medicare Advantage NovaHealth Collaboration	4 Years	5
3	2012	Colla CH	Physician Group Practice Demonstration	5 years	9
4	2012	Salmon RB	Cigna Collaborative Accountable Care model	1 year	6
5	2012	Song Z	Alternative Quality Contract	2 Years	7
6	2013	Colla CH	Physician Group Practice Demonstration	5 years	9
7	2013	McWilliams JM	Alternative Quality Contract	1-2 years	9
8	2014	Chien AT	Alternative Quality Contract	2 Years	7
9	2014	Colla CH	Physician Group Practice Demonstration	4 years	9
10	2014	McWilliams JM	Medicare Pioneer and Shared Savings Program	1 year	9
11	2014	Pope G*	Physician Group Practice Demonstration	5 years	9
12	2014	Song Z	Alternative Quality Contract	4 years	7
13	2015	Barry CL	Alternative Quality Contract	3 years	8
14	2015	McWilliams JM	Medicare Pioneer Program	1 year	9
15	2015	Nyweide DJ	Medicare Pioneer Program	2 years	9
16	2015	Schwartz AL	Medicare Pioneer Program	1 year	9
17	2016	Busch AB	Medicare Pioneer and Shared Savings Program	2 years	9
18	2016	Colla CH‡	Medicare Pioneer and Shared Savings Program	2 Years	9
19	2016	Geyer BC	Medicare Pioneer Program	Inpatient Stay	7
20	2016	Herrel LA	Medicare Shared Savings Program	30 days	8
21	2016	Hewner S	New York State Medicaid Program	90 days	7
22	2016	Huskamp HA	Alternative Quality Contract	3 years	7
23	2016	McWilliams JM	Medicare Shared Savings Program	1 year	9
24	2016	Muhlestein D	Public and Commercial ACOs	1 year	6

25	2016	Ramirez AG	Medicare Pioneer Program	1 year	5
26	2016	Stuart EA	Alternative Quality Contract	3 years	9
27	2017	Winblad U	Medicare Pioneer and Shared Savings Program	30 days	9
28	2017	Zhang Y	Medicare Pioneer Program	1 year	9
29	2017	McWilliams JM	Medicare Shared Savings Program	1 Year	9
Federally Funded Reports					
30	2012	RTI*	Physician Group Practice Demonstration	5 Years	9
31	2015	US GAO	Medicare Pioneer Program	2 Years	6
32	2016	L&M	Medicare Advance Payment ACO	5 years	9
33	2016	L&M	Medicare Pioneer Program	3 years	7
Peer reviewed publications, no non-ACO control group					
34	2012	Share DA	Physician Group Incentive Program	4 years	6
35	2015	Kelleher KJ	Ohio Medicaid Partners for Kids Program	6 years	5
36	2015	Christensen EW	Minnesota Medicaid ACO	3 years	7
37	2015	Singh S	Medicare ACO Programs	1 Year	3
38	2016	Christensen EW	Minnesota Medicaid ACO	3 years	7
39	2016	Peiris D	Public and Commercial ACOs	4 Years	4
40	2017	McConnell JK	Oregon and Colorado Medicaid ACO Programs	2 Years	7
41	2017	Song Z	Alternative Quality Contract	7 Years	8
42	2017	Narayan AK	Medicare Shared Savings Program	3 years	6
Qualitative Analyses					
43	2016	Chien	Alternative Quality Contract	n/a	n/a
44	2016	Berenson	Not Stated	n/a	n/a
45	2016	Fullerton	Medicare ACOs	n/a	n/a
46	2016	Hefner	Private ACOs	n/a	n/a
Notes: ACO=Accountable Care Organization; US GAO=United States Government Accountability Office;					
*Papers use the same analysis, one is peer-reviewed					
†Quality assessed using the Newcastle-Ottawa Assessment Scale for Cohort Studies					

Table 4. Description of ACO Programs Evaluated by Studies included in this Systematic Review

Program	Physician Group Provider Demonstration	Aetna/Novahealth Medicare Advantage Pilot	BCBS-MA Alternative Quality Contract
Time Frame	2005-2010	2008-2011	2009-present
Description	Mandated by the Medicare, Medicaid, and SCHIP Benefits Improvement and Protection Act of 2000 to improve care for Medicare FFS beneficiaries. 10 participating physician groups across 4 census regions, with risk adjustment using retrospective patient assignment	National Medicare Advantage plan defined by collaboration between Aetna and NovaHealth to improve care for Medicare Advantage beneficiaries, prospective assignment.	This initiative included Massachusetts provider organizations participating in Blue Cross Blue Shield HMO and POS plans. Unlike FFS based ACOs, only HMO and POS plan enrollees were eligible, and ACO attribution was determined by the designated primary care physician.
Incentives	Under the PGP Demonstration, practices could share a maximum of 80 percent of savings they earned beyond the minimum savings requirement that was fixed at 2 percent. CMS compared the participating practice's performance against a local comparison "control" group with respect to total per beneficiary expenditures for Medicare Parts A&B.	The 3 year financial agreement included the current fee-for-service reimbursement plus an enhanced per member per month payment for achieving mutually agreed-on quality and efficiency goals (4 quality measures plus Hospital inpatient avoidable days or admissions per 1,000). Shared savings component planned.	Defining features include a global budget with annual spending growth limits, incentive payments to improve quality (up to 10% of revenue), and technical support for participating groups. Organizations receive quality bonuses that are based on 64 measures, including data on processes, outcomes, and patients' experiences.
Care Strategies	Interventions included: chronic disease management programs, high risk/high cost care management, transitional care management, end-of-life/palliative care programs, practice standardization, and quality improvement programs.	Provides care management services, including specialized programs such as the Aetna Compassionate Care Program for members with advanced illness.	Uses the patient-centered medical home and enrollees designate a primary care physician. The PCP's organization is accountable for all enrollee services, regardless of whether the enrollee receives care from the PCP, the PCP's organization, or any other provider.
Number of ACOs	10	1 (750 Aetna Medicare members)	1 (Blue Cross Blue Shield of Massachusetts network as of 2012)
Sources	Pope et al., 2012; Kautter et al., 2014	Claffey 2012	Chernew 2011; Song 2014; Song 2012

Table 4. Description of ACO programs evaluated by studies included in this systematic review (con't)

Program	Cigna Collaborative Accountable Care	Pioneer ACO Model	Medicare Shared Savings
Time Frame	2010	2012-2015	2012-2016
Description	A shared-savings accountable care model, similar to MSSP, with collaborative support from the payer across three geographically and structurally diverse provider practices in Arizona, New Hampshire, and Texas.	Centers for Medicare and Medicaid Innovation (CMMI) developed the Pioneer ACO Model to test alternative design elements, including risk adjustment using prospective patient assignment.	Providers continue to receive traditional Medicare fee-for-service (FFS) payments under Parts A and B, while assuming responsibility for a portion of the annual per beneficiary spending differential relative to benchmarks with risk adjustment using retrospective patient assignment
Incentives	Payer pays a care coordination fee in addition to support in informatics, care coordination, and consultation to participating practices. Payer also provides interim quality and cost results. The better a practice performs in comparison to its goals, the larger its care coordination fee for the following year.	3 year contracts with a higher portion of shared savings and shared risk than MSSP tracks 1 and 2 with the same quality targets as MSSP.	3 year contracts with levels of shared savings and shared risk: no risk in track 1; 40%-60% of losses in track 2; and 40-75% of losses in track 3. Of 418 Medicare ACOs, 6 had enrolled in track II and 16 in track 3 for 2016. In order to qualify for a shared savings payment the ACO must meet 32 specified quality targets across four domains (patient/caregiver experience, care coordination/patient safety, preventive health, and at-risk population).
Care Strategies	Practices must commit to establishing an embedded care coordinator (registered nurse) position.	Provider led	Provider led
Number of ACOs	1	32 (2013)	418 (2016)
Sources	Salmon 2012	CMS	CMS

Table 5. Studies Assessing Use, Processes of Care, and Outcomes of Care by Significance Level in Medicare Only and Non-Medicare Settings

	Outcome Measure (direction of effect)	*Significant Difference*		*No Significant Difference*
	Utilization			
Acute	Inpatient use (decrease)	6†, 11, 15, 18, 23‡, 29, 3		13*, 17*, 19, 20†, 26*
Acute	Emergency Department Visits (decrease)	11, 15, 18, 30	21	3, 17*
Acute	Readmissions/Preventable admissions (decrease)	3, 18**, 23‡, 24, 27§, 32	21, 24	7, 14, 15, 17*, 20†, 23, 29, 32
Acute	Intensive Care Unit (decrease)	6†		19
Acute	Low Value Services and Imaging (decrease)	15, 16, 19		9‖, 23
Non-Acute	Primary Care Visits (decrease)	15		17*, 26*
Non-Acute	Follow up visit after acute care (increase)	15		17*, 21, 32
Non-Acute	SNF/Home Health (decrease)	15, 29		
Non-Acute	Hospice Referral and hospice days (decrease)	6†, 15		
Non-Acute	Part D Prescriptions (increase)			28
	Processes of Care			
	Preventive Care Metrics (improve)	11, 30	1, 5, 8, 22	7, 23
	Chronic disease Management (improve)	11, 14, 30	1, 5, 7¶	4, 8, 23
	Mental Health Care Quality (improve)		13*, 26*	17*
	Value Based Purchasing (improve)			24, 25
	Outcomes of Care			
	Patient Experience (improve)	11, 16		10
	Surgical Complications (decrease)			20†
	Mortality (decrease)	7†		20†, 29, 32

Notes: Results from *studies without a control group were not assessed, and results from studies #2 and #13 (both studies of non-Medicare ACOs) are excluded because statistical significance was not assessed.*

*Users of mental health services

†Cancer patients

‡Asthma/Chronic Obstructive Pulmonary Disease

§Discharged to skilled nursing facility following hospitalization

‖Cardiovascular discretionary imaging and procedures

¶Spillover Effect

CHAPTER 4. MEDICARE SHARED SAVINGS ACOS AND STROKE OUTCOMES: FINDINGS FROM *GET WITH THE GUIDELINES–STROKE*

4.1 Introduction

Since 2010, at least 900 Accountable Care Organizations (ACOs) have formed over 1,300 payment contracts with public and commercial payers, and Medicare accounted for 563 of those contracts in 2017.[1-3] ACO contracts aim to align economic incentives with coordination of care, population health management, and care management programs.[87,102-104] The Centers for Medicare and Medicaid Services (CMS) implemented the Medicare Shared Savings Program (MSSP) to allow provider groups to retain a portion of the savings (or losses) generated by the coordination of care for Medicare fee-for-service (FFS) beneficiaries, within the FFS reimbursement structure. As a result of these contract incentives, ACOs are expected to shift care from high-cost inpatient settings to home and outpatient settings. However little is known about the impact on post-discharge inpatient use following ischemic stroke for elderly Medicare beneficiaries.

At a cost of $30 billion annually, health services use remains high over the year following hospitalization for stroke, and post-acute care is typically provided in skilled nursing facilities (SNFs), inpatient rehabilitation facilities (IRFs), home health agencies, and/or outpatient rehabilitation settings.[7,24] One in five Medicare stroke patients are readmitted within 30 days, with higher rates among patients with multiple chronic conditions.[24,33,44] Post-stroke care delivery may be impacted by ACO strategies including discharge planning, care management, and transitions of care to reduce preventable rehospitalization.[13-21,98]

Reduced inpatient use is consistently associated with ACO alignment among Medicare beneficiaries.[5,27,53] Reductions in discharge to facilities rather than home and greater per capita savings have been reported among among hospitalized and clinically vulnerable beneficiaries.[32,109,110,136] The skilled nursing facility (SNF) is a common setting for post-stroke care, and reductions in 30-day hospital readmissions have been observed among hospitalized patients discharged to SNFs.[110] In addition, implementation of care management programs may improve anticoagulant persistence and adherence impacting long term clinical outcomes (e.g., reduce recurrent stroke and mortality).

Existing studies of MSSP using claims data have limited controls for case mix and severity, which are critical adjustment factors for assessment of clinical outcomes. Get With The Guidelines®–Stroke (GWTG–Stroke) was implemented by the American Heart Association/American Stroke Association (AHA/ASA) to improve the quality of care and outcomes for stroke and transient ischemic attacks by promoting consistent adherence to evidence-based guidelines. This national registry, which includes 2 million discharges since 2003 at over 1,700 hospitals, provides a rich inventory of patient-level clinical factors and medical history to facilitate robust assessment of the impact of ACOs on stroke care.

The objective of this study was to evaluate the association of the MSSP (hospital participation and beneficiary alignment) with use and clinical outcomes in the year following hospitalization for incident ischemic stroke. We hypothesized that MSSP ACOs would reduce post-discharge acute care use (e.g., discharge to facility rather than home, rehospitalization, inpatient days) after stroke without adversely impacting one-year clinical outcomes (e.g., recurrent stroke, all-cause mortality).

4.2 Methods

The goal of this study is to compare one-year outcomes among two populations: 1) patients with incident stroke presenting at a hospital participating in an MSSP ACO contract (referred to as MSSP hospital) or assigned to an MSSP ACO by CMS (referred to as ACO-aligned), and 2) stroke patients with neither MSSP exposure. To achieve this objective, the study used hospitalization data from the national registry GWTG–Stroke linked to Medicare FFS claims files in an observational, difference-in-difference study design.

Data Sources

Hospitalization records from GWTG–Stroke registry for admissions in years 2010 to 2014 were linked to CMS denominator and inpatient claims files for years 2010 to 2015 using a validated algorithm.[57] GWTG–Stroke is a high-quality data source for a sample with similar characteristics to the national Medicare stroke population and includes patient-level data on patient clinical risk factors, diagnostic testing results, and in-hospital outcomes as well as hospital characteristics including ownership, stroke center status, teaching hospital status, number of beds, rural status, and Census region.[58-60] These data were merged with CMS MSSP provider- and beneficiary-level files for performance years 2013 and 2014, the Area Deprivation Index (ADI),[137] and the Area Heath Resource File (AHRF) for years 2010 to 2014 to obtain county-level socioeconomic characteristics. Inpatient claims data available through September 2015 enabled follow-up for outcomes beyond December 2014.

Study Population

The sample included Medicare FFS patients hospitalized in a hospital participating in the GWTG–Stroke registry between January 2010 and December 2014 who were age 65 or older with a physician-adjudicated diagnosis of ischemic stroke and linked to CMS claims. Duke University institutional review board determined that the study did not involve human subjects

and was thus exempt from review. Quintiles is the data collection coordination center for the American Heart Association/American Stroke Association Get With The Guidelines® programs. Exclusion criteria include prior stroke, admission year greater than discharge year, missing all prior medical history, or registered at sites missing more than 25% of registry data. Beneficiaries who linked to CMS FFS claims but were not FFS at the time of hospital discharge were excluded (N=24,124). Additional exclusions following linkage were patients with inpatient death (n=19,742), discharge disposition as Left Against Medical Advice (n=838), or missing AHRF, race, or discharge disposition (n=1,881). Finally, patients identified as limited life expectancy at discharge (discharge to hospice; comfort measures only; National Institutes of Health Stroke Scale (NIHSS) score of ≥16; provider-reported limited life expectancy; or GWTG mortality risk prediction score > 0.15)[138] were excluded (N=54,128) from the analyses presented in this chapter because the care trajectories are expected to be much different in this subgroup than in the rest of the sample, resulting in a final analysis sample of 251,605 (Figure 10).

Measures

Exposure: Separate ACO status measures for hospital and beneficiary community provider participation were obtained from the CMS MSSP provider- and beneficiary-level files for performance years 2013 and 2014. Two treatment groups were defined: 1) hospitals participating in an MSSP ACO contract and 2) ACO-aligned beneficiaries. The difference-in-difference model included two key binary variables whose interaction identifies the effect of MSSP implementation. First, discharge records at hospitals participating in an MSSP in any year during the study period composed the 'MSSP Hospital' group. Second, discharge records at MSSP hospitals occurring after the date of the hospital's MSSP contract initiation composed the 'Post-MSSP' group. The interaction of MSSP Hospital and Post MSSP defined the differential

change from pre-MSSP to post-MSSP participation relative to the concurrent change in the group with no MSSP participation conditional on year.

Second, ACO-aligned beneficiaries included all beneficiaries assigned to an MSSP ACO by CMS, including those hospitalized at non-MSSP hospitals. The binary indicator for ACO-aligned beneficiaries identified patients assigned to any MSSP ACO in the quarter prior to discharge using the preliminary quarterly assignment.[55] Because stroke patients may not survive long enough following discharge to be assigned using the claims algorithm, ACO assignment was drawn from the period prior to hospitalization to avoid selection bias for patients with short survival in the period directly following discharge.

Study Outcomes

Measures of acute care use in the year following discharge included 1) discharge to home (registry data), 2) number of all-cause hospital admissions, and 3) Days Alive and Out of Hospital (DAOH).[139] DAOH is calculated as the number of days alive and on FFS and spent outside of a hospital or IRF. Clinical outcomes in the year following discharge included time (days) to 1) all-cause rehospitalization, 2) recurrent stroke, and 3) all-cause mortality. A recurrent stroke was identified by a principal diagnosis on an inpatient claim including ICD-9 codes 430, 431, 432, 433.x1, 434.x1, or 436 for a hospitalization or observation stay in the year following discharge.[66] All-cause mortality rather than stroke-specific was included because a high proportion of deaths (44%) following stroke are due to non-stroke causes.[67] Days of follow-up were censored at the first non-FFS day after discharge, one year of follow-up, death, or end of study period (December 31, 2015, except outcomes using ICD-9 code definitions ended October 1, 2015).

Patient, Hospital, and County Characteristics

Patient data provided by GWTG include age, race, gender, Hispanic ethnicity, dual eligible status, medical history, stroke severity as measured by the National Institutes of Health Stroke Scale (NIHSS), and health status at discharge. Measures of health status included laboratory values (continuous), unable to ambulate (binary), and the Modified Rankin Scale (categorical). Chronic kidney disease was defined using estimated creatinine clearance (categorical).[70] Due to the high levels of missing values for NIHSS and measures of health status, excluding these observations could introduce substantial bias to the model. Patient covariates missing more than 1% of values were imputed using multiple imputation by fully conditional specification, a powerful and statistically valid method for creating imputations in large data sets.[71]

Models include five-year age categories as well as the interaction of sex and age group to allow for nonlinear effects of age.[21,32] Race/ethnicity categories includes White, Black, Hispanic, Asian, and Other. Binary indicators for risk factors at time of stroke hospitalization (current smoker, hypertension, diabetes, myocardial infarction, heart failure, and atrial fibrillation) and Medicaid dual eligibility are used. Hospital factors include number of beds (continuous), Census region (categorical), and binary indicators for rural status, teaching hospital, primary stroke center, and for-profit ownership. Market factors obtained from the AHRF include continuous measures for proportion over age 65, number of primary care physicians per 10,000 residents, proportion of households in poverty, and total population (log).

ACO Characteristics

ACO characteristics included year of entry into ACO (2012, 2013, or 2014), and ACO experience (> 1 vs. ≤ 1 year in MSSP), primary care focus (> 10 vs. ≤10 primary care providers

per 1000 beneficiaries), specialty focused (> 10 vs ≤ 10 specialists per 1000 beneficiaries), and size (>20,000 vs ≤ 20,000 beneficiaries). Two additional binary measures were also evaluated: MSSP market penetration (> 30% vs. ≤ 30% of hospital discharges aligned with any MSSP ACO), and ACO care continuity (beneficiary assigned vs. not assigned to the same MSSP ACO in which the hospital participates).

Analyses

A difference-in-difference (DD) design was used to estimate the changes in the outcome in the ACO group from the baseline to the post-ACO periods that differ from the concurrent change in the control group. Because the MSSP is a voluntary program, providers who decide to participate may differ from providers who do not in ways that impact the outcomes. If providers who provide higher quality care are more likely to join ACOs and have better patient outcomes, then a model that does not control for the difference in provider quality would overestimate the effect of the program itself. The DD method controls for unobserved differences between the treatment and control groups at baseline that do not change during the study period, an assumption supported in prior studies.[5,21,27,29,32,33,72] The interaction of MSSP Hospital and Post-MSSP defines the differential change (DD) from pre-MSSP to post-MSSP participation relative to the concurrent change in the group without MSSP participation in a given year.

For each outcome, estimates from two models are presented: 1) MSSP hospital DD not controlling for beneficiary MSSP status (Eqn 1); 2) MSSP hospital DD controlling for beneficiary MSSP status (Eqn 2).

$$L_{ijt} = f(a + \beta X_i + \beta X_{jt} + \beta HRR_j + \beta Year_t + \beta D_j + \delta DD_t + \varepsilon_{ijt}) \quad \text{Eqn 1}$$

$$L_{ijt} = f(a + \beta X_i + \beta X_{jt} + \beta HRR_j + \beta Year_t + \beta D_j + \delta DD_t + \gamma ACO_i + \varepsilon_{ijt}) \quad \text{Eqn 2}$$

where L is the outcome of individual *i* treated in hospital *j* at time *t*, *f* is the link function. In the first model, DD represents the total effect of MSSP hospital, for MSSP-aligned and non-aligned beneficiaries. The referent group in the former model includes MSSP-aligned beneficiaries hospitalized at non-MSSP hospitals. In the second model, DD represents the net effect of MSSP hospital participation (presumably through acute care pathways) independent of beneficiary MSSP alignment (presumably through primary care pathways). The referent group in the latter model consists of beneficiaries neither ACO-aligned nor hospitalized at an MSSP hospital. Variation in the effect by ACO characteristics was evaluated by adding an interaction with DD to the model not controlling for beneficiary MSSP status.

Negative binomial models with a log link were used to estimate incidence rate ratios for use outcomes (e.g., discharge to home, admissions, DAOH). For admissions and DAOH, an offset for log of the proportion of follow-up time within one year after index discharge was used to account for time at risk during the follow-up period.[140] Cox proportional hazards models were used to evaluate time to event outcomes (e.g., rehospitalization, recurrent stroke, mortality).

The wide variation in regional usage patterns may bias our estimates if ACO penetration is correlated with regional rates of service use. Statistical models evaluated changes using Hospital Referral Regions (HRRs) fixed effects to control for the unobserved, time-invariant differences between HRRs. In survival analyses, models were stratified by HRR to allow the baseline hazard rate to vary by HRR rather than a dummy variable approach, which can introduce bias.[77] Year and month fixed effects were also included to account for changes over time and seasonal variation in outcomes.[74]

4.3 Results

The analysis sample included index hospitalizations for 251,605 unique beneficiaries who did not have limited life expectancy based on their stroke hospitalization record (Figure 10).

Eligible hospitalizations that linked to CMS FFS claims (N=352,318) were compared with those unable to link (N=222,818), including Medicare advantage hospitalizations and unlinked FFS hospitalizations. Patient demographics, medical history, clinical measures, and hospital factors were not substantially different (standardized difference <0.2) between the two groups except for older age and fewer West Census region hospitalizations (standardized difference =0.24) among FFS-linked.

Table 6 compares the patient, hospital and country characteristics for beneficiaries discharged from MSSP hospitals (n=87,183) vs. non-MSSP hospitals (n=21,499) prior to the implementation of the MSSP program (January 2010 to April 2012). Prior to implementation of MSSP, standardized differences in patient characteristics were small in magnitude (<2 percentage points), except patients at MSSP hospitals are more likely to have private insurance (e.g., Veterans Affairs or supplemental Medicare policy) with 40% relative to 35% in the non-MSSP group. Relative to non-MSSP hospitals, MSSP hospitals were larger, more urban, more likely to be a teaching hospital, and located in counties with lower poverty rates and higher rates of primary care physicians. Differential changes in the MSSP group in the post-MSSP period were observed primarily among hospital and county characteristics rather than patient characteristics.

Difference-in-Difference Results

Table 7 shows unadjusted baseline rate ratios as well as unadjusted and adjusted differential changes in event rates for discharges from hospitals participating in MSSP versus not participating. Prior to the start of an MSSP contract, MSSP versus non-MSSP hospitals had 4% lower rates of discharge to home (Incidence Rate Ratio (IRR)=0.96; 95% Confidence Interval (CI)=0.94,0.98) and 4% higher rates of rehospitalization (Hazard ratio (HR)= 1.04, CI=1.02, 1.05) within one year. Differential changes in event rates were not significant prior to adjustment

for covariates. In the adjusted DD model, MSSP versus non-MSSP was associated with a 5% differential reduction in discharge to home (IRR=0.95; CI=0.92, 0.98), however discharge from MSSP versus non-MSSP hospital was not significantly associated with differential changes in other outcomes. Among patients not discharged to home, 41.2% were discharged to SNF and 53.2% were discharged to IRF among discharges at MSSP hospitals relative to 42.3% and 50.4% at non-MSSP hospitals.

ACO-Aligned Beneficiary Results

From the models controlling for beneficiary MSSP alignment, the adjusted DD estimates as well as the estimate for the association of MSSP-aligned beneficiaries with outcomes are presented for each of the clinical and use outcomes (Figure 11). Similar to the DD results, receiving stroke care at a MSSP versus non-MSSP hospital was associated with a 6% differential reduction in the rate of discharge to home (IRR=0.94; 95% CI= 0.92, 0.97). At a rate of 1.72 pre-MSSP, a 6% change represents approximately 30 discharges per 1,000. MSSP versus non-MSSP hospital use was not associated with a differential change in the rate of subsequent hospital admissions, however, relative to non-aligned beneficiaries, ACO-aligned beneficiaries had 5% higher rate of subsequent hospital admissions in the year following stroke discharge (IRR=1.05; CI=1.02, 1.07). At a baseline rate of 1.72 per person year, this change would be equivalent to 86 additional hospitalizations per 1,000 per person year. No significant associations were found with DAOH for either MSSP versus non-MSSP hospitals or ACO-aligned versus non-aligned beneficiaries. Among the clinical outcomes, the differential change in rehospitalization for MSSP versus non-MSSP hospitals was not significant, however ACO-aligned versus non-aligned beneficiaries had 3% higher adjusted rate of rehospitalization (HR= 1.03; CI=1.00, 1.05). No evidence of an association between MSSP at either level and recurrent stroke or mortality was observed.

ACO Characteristics

In the analysis exploring how ACO characteristics might moderate the effect of MSSP, only ACO size was associated with a significant ($p < .05$) difference in the effect of MSSP on rates of discharge to home. ACOs with more than 20,000 covered beneficiaries had higher rates of discharge to home relative to ACOs with less than 20,000 beneficiaries (IRR=1.04; CI=1.00, 1.09). No significant differences were found by ACO start year, number of providers or number of specialists. Estimates for a heterogeneous effect due to care continuity, ACO market penetration, county area deprivation index, or county PCP supply were not significant.

4.4 Discussion

This study evaluated the association of the MSSP hospital participation or beneficiary ACO-alignment with use and clinical outcomes in the year following hospitalization for ischemic stroke. Rather than shifting post-stroke care to lower intensity care settings, hospital participation in MSSP was associated with a significant decrease in the rate of discharge to home, meaning greater use of other care settings like SNF and IRF for post–acute care, relative to hospitals not participating in MSSP. Compared with beneficiaries with no MSSP participation, ACO-aligned beneficiaries had increased risk of rehospitalization in the year following stroke. These unexpected results in this high-risk population could have implications for ACOs providing care to stroke patients as well as the implementation of MSSP.

The observed increase in the number of hospital admissions in the year following incident stroke for ACO-aligned beneficiaries contrasts with evidence that ACOs reduce inpatient use.[4,5] Contrary to our finding of an increase in discharge to facilities other than home, a different study found a reduction in discharge to facilities was found for all-cause hospitalizations among Medicare beneficiaries.[109] However, the evidence is mixed for high-risk, hospitalized subgroups like stroke. For example, multiple studies that found reductions in

inpatient days failed to find reductions in all cause readmission rates.[5,27,109] In fact, small but significant increases in 30-day readmissions were found among a subgroup of clinically vulnerable patients, in which stroke was a top diagnosis group.[32,136] In this context, our findings suggest effects of MSSP on post-discharge acute care may not be consistent across diagnosis groups.

Despite the differential increase in rate of admissions following stroke hospital discharge, we did not observe a corresponding increase in number of inpatient days among ACO-aligned beneficiaries. ACOs may be more effective in shortening inpatient length of stay through transfer to post–acute care rather than preventing subsequent admissions. Admissions for preventable causes account for less than 2% of 30-day readmissions following ischemic stroke, and a reduction in non-preventable admissions would not reflect appropriate care.[44] In addition, increased admissions may be driven by increased use of IRF, which have been associated with improved patient outcomes, as opposed to less intensive care settings (e.g., skilled nursing facility or home health).[141] Although we found no change in one-year clinical outcomes, further work is needed to understand how MSSP impacts quality of post–acute care and patient-centered outcomes.

Both hospital participation and beneficiary ACO alignment contributed to changes in use at different points in the care trajectory; for example, hospital status was associated with discharge setting whereas beneficiary status was associated with subsequent admissions. In addition to improving internal care processes, ACO providers also employ external patient support personnel who have little interaction with providers' day-to-day practices.[98] Through these added programs, ACO-aligned patients may receiving different services and have different outcomes than non-aligned patients receiving similar care from the same ACO providers.

Despite the potential for improved care integration within an ACO providing both acute and primary care, we found no evidence of a benefit for patients aligned with the same ACO providing their acute stroke care.

Current quality metrics and incentives in MSSP contracts may not be sufficient to generate changes in post-stroke care. Incident stroke patients compose a relatively small segment of an ACO population in a given year (less than 1%).[142] As a result, changes in stroke care would only move the needle on per capita costs for large-magnitude patient-level savings. Early ACO savings have resulted from small shifts among large segments of the patient population rather than relatively smaller segments of high-cost patient groups.[143] Of the 33 MSSP quality measures in 2013–2014, two relate to patients with ischemic vascular disease—targeting the completion of lipid profiles and low density lipoprotein control via use of aspirin or other anti-thrombotics.[144] Even when ACO strategies are not specific to stroke care, systemic changes may impact care for stroke patients. New quality measures that may impact patients with stroke are being phased in during 2017 to 2019, including 1) all-cause unplanned admissions for patients with multiple chronic conditions, 2) documentation of current medications, and 3) medication reconciliation post-discharge.[145] The implementation of these measures may increase the impact of MSSP on care transitions and post–acute care.

Limitations

Our findings should be interpreted in the context of several limitations. MSSP provided a pathway for gradually assuming risk for nascent ACO systems, and these early results may not reflect the potential impact of systemic improvements that require years to implement fully. Our models controlled for health status at discharge, so our estimates would underestimate the total effect if acute care quality improved with MSSP, despite the high baseline quality of care at

participating hospitals. Larger hospitals are more likely to participate in the GWTG–Stroke registry, so the generalizability of these results to smaller, more rural institutions is limited.[58] Patient ACO alignment is not randomized, and assignment may be correlated with differences between the treatment and control group that are not captured by the observable characteristics—for example, education level or socioeconomic status—however models were adjusted for county-level socioeconomic factors to mitigate the potential for bias.

4.5 Conclusions

MSSP is associated with a lower rate of discharge home. Reductions in acute care use observed in the general Medicare population may not translate to patients with stroke. Current quality metrics and incentives in MSSP contracts may not be sufficient to generate changes in post-stroke care. Population metrics that drive systemic integration and coordination may benefit stroke patients while mitigating the burden of reporting on providers.

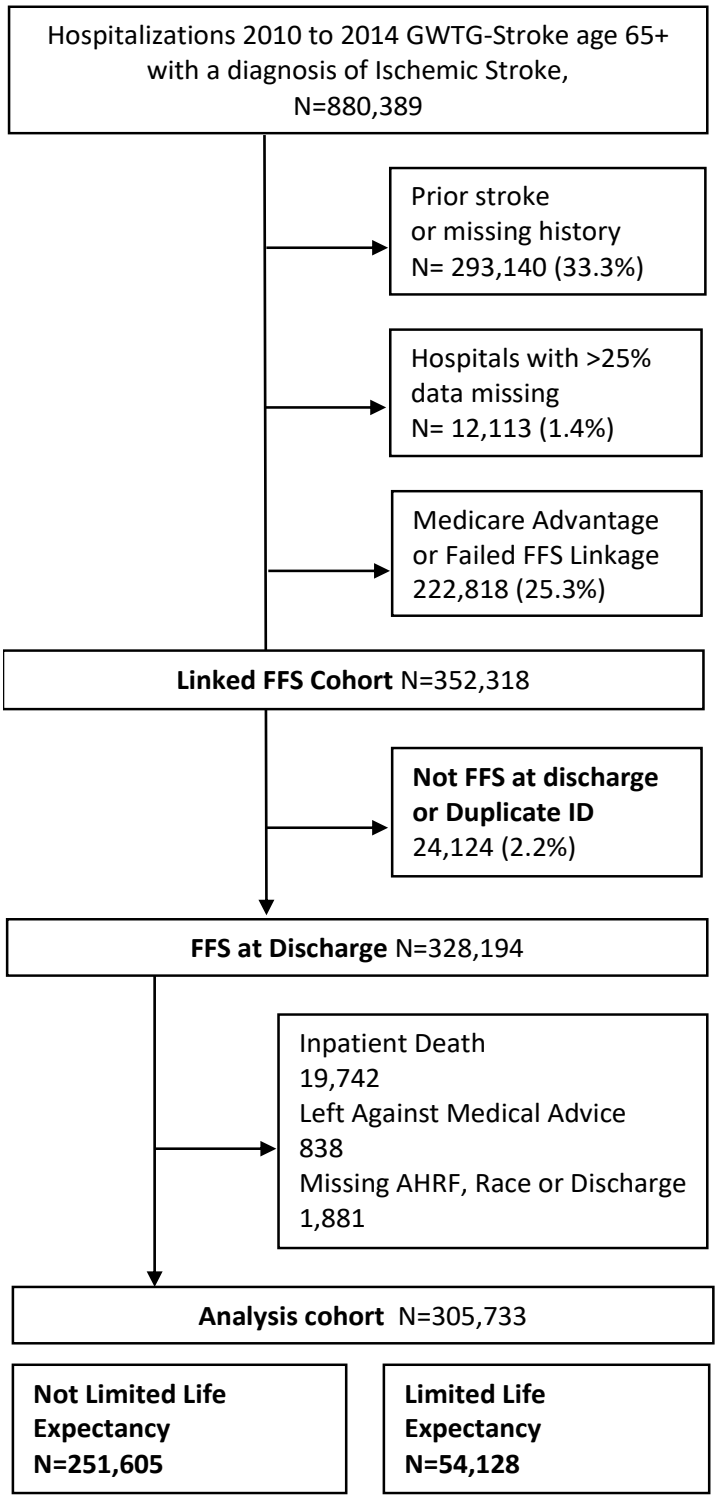


Figure 10. Get With The Guidelines–Stroke 2010–2014 cohort selection.

Table 6. Differential Changes for GWTG–Stroke Discharges from Hospitals Participating in MSSP ACOs Compared to the Control Group, Before and After MSSP ACO Contract Initiation (2010–2014)

Hospital MSSP Status	Non-MSSP	MSSP	Difference between MSSP and Non-MSSP in Precontract Period	Differential Change in MSSP vs Non-MSSP
Number of Discharges	87,183	21,499		
Patient Characteristic	*% or Mean (SD)*	*% or Mean (SD)*	*Difference*	*Mean*
Age, median (25th-75th percentiles)	79.0 (72,85)	79.0 (73,85)	0	0.1
Demographic (%)				
Female	56.1	57.2	1.2	-0.8
Black	9.6	10.8	1.2	-0.7 *
Hispanic	3.9	3.8	-0.1	-0.2 *
Asian	1.9	2.2	0.3	-0.1 *
Medicaid	6.7	6.8	0.1	-1.2 *
Private Insurance	35.5	40.6	5.1	0.0 *
Inpatient Clinical Measures				
NIH Stroke Severity Score	4.2 (3.9)	4.1 (3.9)	-0.1	0.0
Unable to ambulate, %	12.0	13.0	1.0	-1.3 *
CHA2DS2-VASc 2+, %	98.5	98.5	0.0	0.1
Chronic Kidney Disease, %	49.2	49.3	0.1	-0.7
Body mass index, Kg/m^2	27.3 (6.5)	27.2 (6.2)	-0.2	0.0
Diastolic blood pressure, mmHg	71.5 (12.2)	71.4 (12.1)	-0.1	0.1
Systolic blood pressure, mmHg	137.4 (21.0)	137.5 (20.8)	0.2	-0.1 *
A1C measurement (0-20), %	6.4 (1.4)	6.4 (1.4)	0.0	0.0
High Density Lipoprotein, mg/dl)	45.0 (14.6)	45.6 (14.5)	0.6	0.2
Low Density Lipoprotein, mg/dl)	97.9 (37.7)	97.0 (37.1)	-0.9	0.7
Heart rate, beats per minute	78.6 (17.1)	78.6 (17.0)	0.0	0.0
International normalized ratio (0-25)	1.2 (.5)	1.2 (.5)	0.0	0.0
Medical History (%)				
Atrial Fibrillation	21.6	22.7	1.0	-0.9 *
Carotid Stenosis	4.2	4.3	0.1	0.2
Diabetes	31.4	31.3	-0.2	-0.7
Peripheral Vascular disease	5.3	5.5	0.2	0.0
Hypertension	84.6	84.8	0.2	-0.2
Smoking	11.3	10.8	-0.5	0.5
Dyslipidemia	49.4	50.3	0.9	0.0
Heart Failure	9.4	9.7	0.3	-0.2
Transient Ischemic Sroke	10.3	10.1	-0.2	0.3
Hospital Characteristics				
Number of Beds	398.7 (270.9)	441.0 (277.6)	42.3	-0.7 *
Annual Stroke Admissions	310.2 (199.9)	354.5 (235.4)	44.2	12.7 *
Rural, %	6.1	2.8	-3.3	1.0 *
Teaching, %	53.0	68.2	15.2	-3.7 *
Region (%)				
Northeast	24.8	32.63	7.9	3.0 *
Midwest	20.2	26.56	6.4	1.9 *
South	39.0	30.41	-8.6	-2.6 *
West	16.1	10.39	-5.7	-2.4 *
County Characteristics				
Total Population (log)	12.7 (1.5)	13.0 (1.5)	0.3	1.4
Proportion Age 65+	14.2 (3.9)	13.6 (3.4)	-0.6	0.1 *
Proportion Households in Poverty	14.8 (5.2)	13.5 (5.0)	-1.4	0.2 *
# Primary care physicians (per 10	7.6 (3.0)	8.3 (3.3)	0.7	0.0

*p <0.05 regression coefficient on the interaction of hospital MSSP status and post MSSP contract initiation in the naive model with year fixed effects.

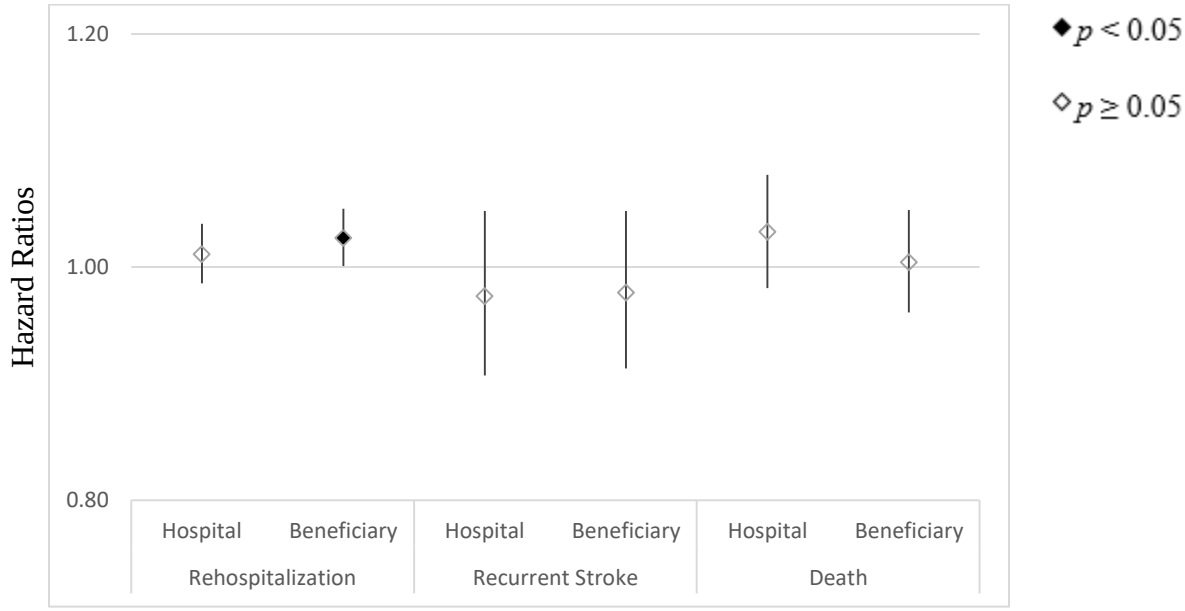
Notes: From the authors analysis of American Heart Association Get with the Guidelines-Stroke registry data linked with Poor functional status is a response of "unable to ambulate" on the Get with the Guidelines form.

Table 7. Differential Changes in Event Rates During the Year Following Discharge from Hospitals Participating in an MSSP Versus Not Participating, Before and After MSSP Contract Initiation (2010–2014)

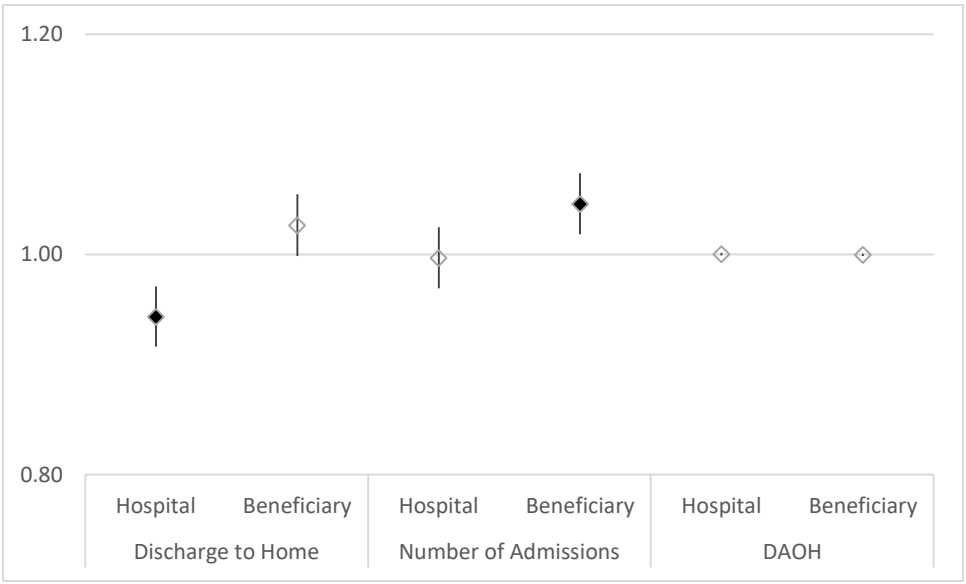
	Prior to MSSP		Post-MSSP	
N=251,605	Discharges at Non-	Ratio of MSSP	Unadjusted DD	Adjusted DD MSSP
One year outcomes	MSSP Hospitals	vs Non-MSSP	MSSP vs Non-MSSP	vs Non-MSSP
Clinical Outcomes	*Rate/PY (CI)*	*HR (CI)*	*HR (CI)*	*HR (CI)*
Rehospitalization	0.64 (0.63,0.64)	1.04 (1.02,1.05)	1.00 (0.97,1.02)	1.02 (0.99,1.04)
Recurrent Stroke	0.08 (0.09,0.08)	1.01 (0.97,1.06)	0.97 (0.90,1.04)	0.97 (0.90,1.04)
Death	0.18 (0.18,0.18)	0.98 (0.95,1.01)	1.01 (0.96,1.06)	1.03 (0.98,1.08)
Utilization Outcomes	*Rate/PY (CI)*	*IRR (CI)*	*IRR (CI)*	*IRR (CI)*
Discharge to home (proportion)	0.49 (0.48,0.49)	0.96 (0.94,0.98)	0.92 (0.80,1.07)	0.95 (0.92,0.98)
Number of admissions	1.72 (1.69,1.74)	1.02 (1.00,1.03)	1.00 (0.97,1.02)	0.98 (0.98,1.03)
DAOH	353.48 (353.7,353.27)	1.00 (1.00,1.00)	1.00 (1.00,1.00)	1.00 (1.00,1.00)

Notes: PY=Person year; CI=95% Confidence Interval; DAOH=Days Alive and Out of Hospital; HR=Hazard Ratio; IRR=Incidence Rate Ratio; IRR were generated using negative binomial models with offset. Hazards ratios were generated using proportional hazards models. All models were adjusted for patient demographics, health status at discharge, medical history, hospital factors, county factors, no evaluation and management visit the year prior to incident stroke and fixed effects for Hospital Referral Region, and year/month of admission.

Panel A: Time to event in the year following hospitalization for stroke

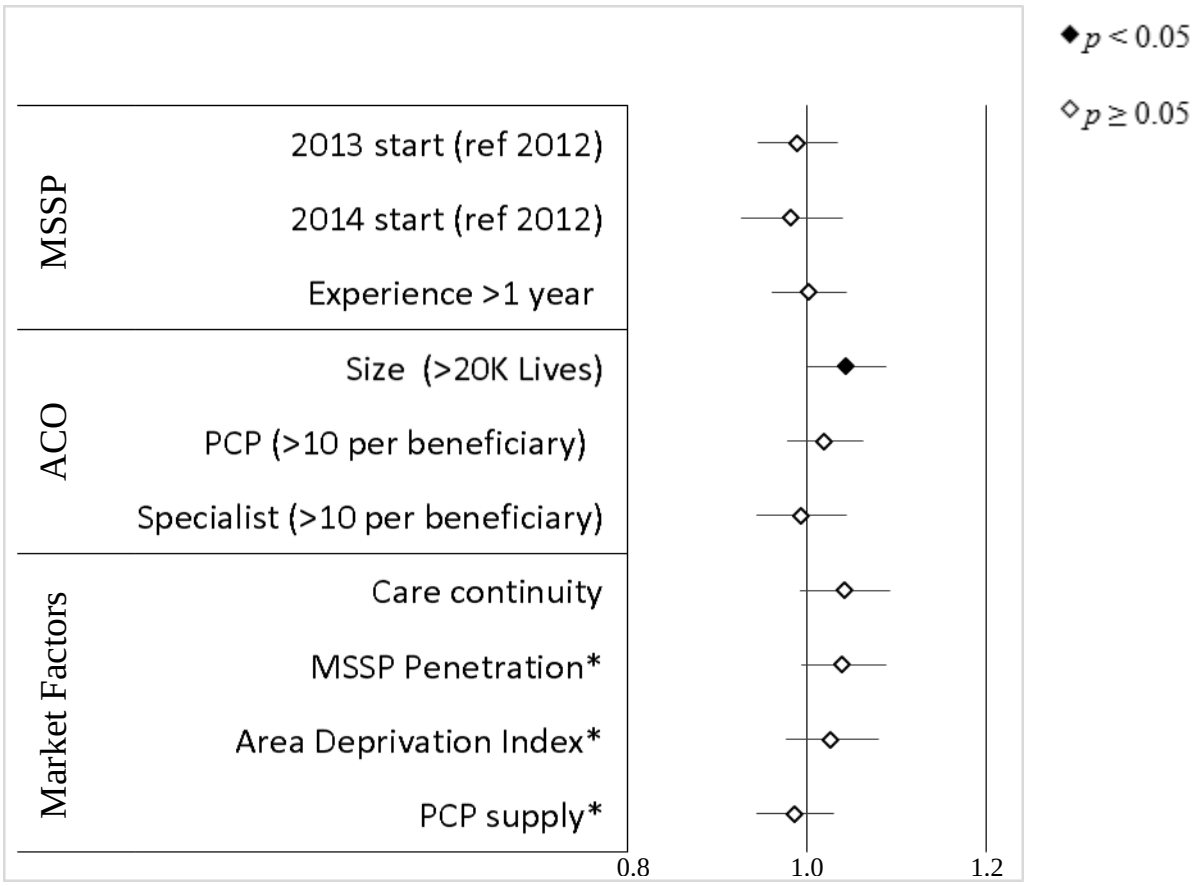


Panel B: Events per PY (admissions, DAOH) or per live discharge (discharge to home)



Notes: PY=Person year. Incidence rate ratio estimates and 95% confidence intervals were generated using negative binomial models with log link and offset for log proportion of follow up days. Hazards ratios and 95% confidence intervals were generated using proportional hazards models. All models were adjusted for patient demographics, health status at discharge, medical history, hospital factors, county factors, no evaluation and management visit the year prior to incident stroke and fixed effects for Hospital Referral Region, and year/month of admission.

Figure 11. Difference-in-difference estimates and 95% confidence intervals for MSSP versus non-MSSP Hospitals and estimates for the association of ACO-aligned beneficiaries with event rates (2010-2014).



* Value > 75th vs ≤ 75th percentile.

Notes: ADI= Area Deprivation Index; PCP= Primary Care Physician; Care continuity (binary) is non-zero when the beneficiary is aligned with the same ACO providing acute stroke care during hospitalization. MSSP market penetration (continuous) is the proportion of hospital discharges where the beneficiary is aligned with any MSSP ACO. Area deprivation and PCP supply are county level factors from the Area Deprivation Index and Area Health Resource File respectively.

Figure 12. Incidence Rate Ratios and 95% confidence intervals for rates of discharge to home among MSSP hospital ACOs with each characteristic relative to those without that characteristic.

CHAPTER 5. MEDICARE SHARED SAVINGS ACOS AND PALLIATIVE CARE FOR STROKE PATIENTS: FINDINGS FROM *GET WITH THE GUIDELINES-STROKE*

5.1 Introduction

Palliative care services, including use of the Medicare hospice benefit, have the potential to improve the quality of end-of-life (EOL) care at reduced cost, yet these services are underused among stroke patients.[9-12,23,146] To improve quality of care and patient experience while controlling costs, accountable care organizations (ACOs) are expected to reduce use of low-value and increase use of high-value services across the care continuum, including palliative care.[45-52] Over half (60%) of ACOs have implemented EOL care planning processes, including care management and use management capabilities, however little is known about whether ACOs are changing use and quality of care at the EOL.[147]

Palliative care, including care provided via the Medicare hospice benefit, is intended to be patient- and family-centered and optimize health-related quality of life by anticipating, preventing, and treating suffering, however these benefits are not fully realized for the 1 in 3 hospice beneficiaries with a hospice stay of less than seven days.[35-41] Although the vast majority of hospice care is provided in outpatient settings, most hospitals (50+ beds) offer inpatient palliative care or hospice services.[148] For patients hospitalized close to the EOL, inpatient palliative care or comfort measures only (CMO) may be preferable to hospice services; EOL care planning processes are more common in ACOs with a participating hospital than in community provider groups.[147]

Despite the expectation of increased use of palliative care services, Medicare ACO programs have been associated with reductions in per capita hospice days among Medicare

beneficiaries.[4] This could reflect reductions in appropriate use of a high-value service; alternatively, the shift could be driven by changes in the tails such as fewer stays of longer than 180 days. The latter could reduce hospice costs while maintaining or improving appropriate use of the hospice benefit. Proxies for potentially appropriate hospice use in ACOs such as enrollment among patients with limited life expectancy (LLE), timing of hospice enrollment relative to death, and live discharge rates remain largely unstudied.

The objective of this study was to evaluate the association of the MSSP (hospital participation and beneficiary alignment) with quality of EOL care following incident ischemic stroke. Two specific hypothesis under this objective are: 1) MSSP will be associated with increased inpatient CMO and hospice use among patients with LLE, and 2) MSSP will be associated increased length of hospice use (e.g., median hospice days) among hospice users.

5.2 Methods

This study compares outcomes among two incident stroke populations: 1) patients presenting at a hospital participating in an MSSP ACO contract (referred to as MSSP hospital) or assigned to an MSSP ACO by Centers for Medicaid and Medicare Services (CMS) (referred to as ACO-aligned), and 2) stroke patients with neither MSSP exposure. To achieve this objective, we employed hospitalization data from the national Get with The Guidelines (GWTG)–Stroke registry linked to Medicare fee-for-service (FFS) inpatient and hospice claims files using an observational, difference-in-difference study design.

Data Sources

Hospitalization records from GWTG-Stroke registry for admissions from 2010 to 2013 were linked to CMS denominator and inpatient claims files between 2010 and 2015 using a validated algorithm.[57] The GWTG–Stroke registry provides a high quality data for a sample similar to the national Medicare stroke population. Quintiles is the data collection coordination

center for the American Heart Association/American Stroke Association Get With The Guidelines® programs. The registry includes patient-level data on patient clinical risk factors, diagnostic testing results, and in-hospital outcomes as well as hospital characteristics including ownership, stroke center status, teaching hospital status, number of beds, rural status, and Census region.[58-60] These data were merged with CMS MSSP provider and beneficiary-level files for performance year 2013 and the Area Heath Resource File (AHRF) for years 2010 to 2013 to obtain county-level socioeconomic characteristics. Duke University Institutional Review Board determined that the study did not involve human subjects and was thus exempt from review.

Sample

The sample included Medicare FFS patients hospitalized in a hospital participating in the GWTG–Stroke registry between January 2010 and December 2013 who were age 65 or older with a physician-adjudicated diagnosis of ischemic stroke and linked to CMS claims. Exclusion criteria include prior stroke or missing medical history (N=293,140) or patients hospitalized at sites missing more than 25% of registry data (N=12,113). Beneficiaries who linked to CMS FFS claims but were not FFS at the time of hospital discharge were excluded (N=24,124). Additional exclusions following linkage include discharge disposition as Left Against Medical Advice (n=838) or missing AHRF, race or discharge disposition (n=1,881), for a final sample of (N=256,682).

Outcomes among beneficiaries meeting criteria for LLE are evaluated independently from the rest of the sample because the care trajectories are expected to vary between these two groups. Patients were identified as LLE if at least one of the following criteria was met: National Institutes of Health Stroke Scale (NIHSS) score ≥15, contraindication for evidence-based treatment due to provider reported LLE, or GWTG mortality risk prediction (global or ischemic) score > 0.15.[138]

Measures

Exposure

Separate ACO status measures for hospital participation and beneficiary alignment were obtained from the CMS MSSP provider and beneficiary-level files for 2013 and 2014. Two treatment groups were defined: 1) hospitals participating in an MSSP ACO contract and 2) ACO-aligned beneficiaries. The difference-in-difference model included two key binary variables whose interaction identifies the effect of MSSP implementation: 1) MSSP Hospital, defined by discharge records as hospitals participating in an MSSP in any year during the study period, and 2) post-MSSP, defined by discharge records as occurring after the date of the hospital's MSSP contract initiation. The interaction of MSSP Hospital and Post-MSSP defined the differential change from pre-MSSP to post-MSSP participation relative to the concurrent change in the group with no MSSP participation conditional on year.

ACO-aligned beneficiaries included all beneficiaries assigned to an MSSP ACO by CMS, including those hospitalized at non-MSSP hospitals. This binary indicator identified patients assigned to any MSSP ACO in the quarter prior to discharge using the preliminary quarterly assignment.[55] Because stroke patients may not survive long enough following discharge to be assigned using the claims algorithm, ACO assignment was drawn from the period prior to hospitalization; this avoided selection bias for patients with short survival in the period directly following discharge.

Outcomes

Palliative care use included two binary measures: 1) a composite outcome including CMO or discharge to hospice during the index hospitalization and 2) hospice use within one year of discharge. Among hospice users, length of hospice use measures included: 1) hospice enrollment within 7 days of death (binary), which is associated with being enrolled

too late;[149-151] 2) live discharge from hospice (binary), which has been used as a proxy for early enrollment; and 3) total number of days in hospice (continuous) in the two years following index hospitalization.

Patient, Hospital, and County Characteristics

Patient data provided by GWTG include age (five-year age categories), race (White, Black, Hispanic, Asian, and Other), gender, dual eligible status, medical history (current smoker, hypertension, diabetes, myocardial infarction, heart failure, and atrial fibrillation), stroke severity as measured by the NIHSS, and health status at discharge. Measures of health status included laboratory values (continuous), unable to ambulate on admission (binary), and degree of disability as measured by the Modified Rankin Scale at discharge (categorical). Chronic kidney disease was defined using estimated creatinine clearance (categorical).[70] Hospital factors include number of beds (continuous), annual stroke volume (continuous), Census region (categorical), and binary indicators for rural status, teaching hospital, and primary stroke center. County-level factors obtained from the AHRF include continuous measures for proportion over age 65, number of hospice providers per 10,000 residents, number of primary care physicians per 10,000 residents, number of hospice providers per 10,000 residents, proportion of households in poverty, and total population (log).

Analyses

Logistic regression was used to estimate the average differential effect of MSSP on the probability of binary outcomes (e.g., composite outcome, hospice use within one year, short stay, live discharge). Patients surviving less than seven days from the index hospital admission date were excluded from the model predicting short hospice stay because they were not eligible for the outcome. In addition to evaluating mean effects on hospice days using a linear model,

distributional shifts associated with MSSP were evaluated using quantile regressions at the 25th, 50th, and 75th percentiles for hospice days.

Excluding observations with high levels of missing values for NIHSS and measures of health status could introduce substantial bias to the model. Thus, for patient covariates missing more than 1% of values, we used multiple imputation by fully conditional specification, a powerful and statistically valid method for creating imputations in large data sets.[71] All analyses were conducted in SAS version 9.04.01.

5.3 Results

Palliative Care Use by LLE Group

The analysis sample included index hospitalizations for 256,682 unique beneficiaries, of whom 52,090 met the criteria for LLE. Patient demographics and inpatient clinical measures were not substantially different between patients discharged from MSSP versus non MSSP hospitals (standardized difference <0.2) for either subgroup (Table 8). Hospitals participating in MSSP had substantially higher annual volumes of stroke admissions and were more likely to be teaching hospitals (standardized difference ≥0.2). MSSP hospitals were more likely to be located in counties with larger populations, lower poverty rates, and greater supply of primary care physicians than non-MSSP hospitals.

Discharge from MSSP (versus non-MSSP hospital) was associated with a significant ($p<.05$) decrease in our composite outcome (inpatient CMO or discharge to hospice) for non-LLE beneficiaries (Adjusted odds ratio (OR) = 0.78; 95% Confidence Interval (CI) = 0.69, 0.90). However, among patients with LLE, there was no significant association between MSSP status and the composite outcome (OR=1.06; CI=0.95, 1.19) (Figure 13). Among those with LLE, no there was no significant association between MSSP status and the composite outcome (OR=1.06; CI=0.95, 1.19) (Figure 13). Among LLE, beneficiary alignment with an ACO was associated

with a 17% increase in the odds of hospice enrollment in the year following stroke (OR= 1.17; CI= 1.03, 1.23), with a predicted probability from 19.3% among non-aligned and 21.4% among ACO-aligned beneficiaries (Figure 13). Among non-LLE, there was no significant change in hospice enrollment at one year by beneficiary-level ACO alignment (Table 9).

Length of Use Among Hospice Users

Among beneficiaries with any hospice use in the two years following stroke (N=72,115), 41% had a short stay (<7 days) and 12% had a live discharge from hospice. The difference-in-difference analysis found no significant change in either short stay or live discharge from hospice associated with discharge from MSSP hospital (Figure 14), however ACO-aligned beneficiaries have a 38.5% (CI=36.4%, 40.9%) predicted probability of a short stay compared to 41.3% (CI=40.9%, 41.6%) among non-aligned beneficiaries.

The distribution of hospice days varied by LLE status. Among hospice users, the median length of use was 4 days (Interquartile range (IQR) = 2, 13) for beneficiaries with LLE compared to 11 days (IQR= 5, 39) for non-LLE (Figure 15). Quantile regression estimates for the shifts in total hospice days among LLE and non-LLE groups at the 25^{th}, 50^{th}, and 75^{th} percentiles and 95% CI are presented in Figure 16; see Tables 9 and 10 for detailed estimates. Hospital MSSP was significantly associated with an increase in the 25^{th} percentile of hospice days among beneficiaries with LLE (0.63 days, CI=0.33, 0.93) and reduction in median hospice days among beneficiaries without LLE (-1.20 days, CI= -2.38, -0.03) relative to the concurrent change at non-MSSP hospitals in the respective LLE group. In contrast, ACO-alignment among beneficiaries with LLE was associated with a decrease of 1.13 (CI= -1.58, -0.69) at the 25^{th} percentile relative to non-aligned LLE beneficiaries. ACO-alignment among beneficiaries without LLE was associated with an increase in the 25^{th} percentile and median hospice days of 1.39 (CI=0.68, 2.10) and 1.84 (CI=0.19, 3.50), respectively.

5.4 Discussion

We evaluated the association of hospital participation in MSSP and beneficiary ACO-alignment with improved quality of EOL care following incident ischemic stroke. Among beneficiaries with LLE, ACO-alignment was associated with a significant increase in hospice enrollment in the year following stroke, however among patients with low estimated mortality risk at discharge (non-LLE), hospitalization at MSSP hospital was associated with a reduction in the use of inpatient CMO or discharge to hospice. Among non-LLE beneficiaries who went on to enroll in hospice, beneficiary ACO-alignment was associated with an increase of nearly two days in hospice length of use. Our finding of contrasting effects in the subgroups of patients with and with LLE suggests that ACO incentives may encourage use of palliative care among those most likely to benefit, without promoting inappropriate early referral to hospice.

The decrease in CMO and discharge to hospice among stroke patients with low mortality risk is consistent with studies that found reductions in hospice cost per capita among ACO-aligned Medicare beneficiaries nationally.[4] A study of a clinically vulnerable subgroup found no change in hospice spending associated with MSSP.[32] In our cohort, any potential increase in hospice spending resulting from higher rates of hospice enrollment within one year of stroke among ACO-aligned LLE beneficiaries could be offset by reductions in enrollment rates for the rest of the cohort. Given the heterogeneity in effect by estimated mortality risk at discharge, studies evaluating end-of-life spending and outcomes could benefit from data sources providing measures of life expectancy not available in claims.

Among non-LLE hospice users, ACO-aligned beneficiaries had a greater median length of use, which may reflect improved quality of EOL care. An increase of nearly two days in the median hospice number of days is particularly meaningful in this cohort, where the median length of use was only 5 and 11 days among LLE and non-LLE hospice users, respectively. A

previous study found that reporting they had enrolled too late had substantially fewer days in hospice compared to those who said that enrollment was too soon or at the right time (median: 10 versus 24 days, respectively).[152] The perception of being enrolled too late is associated with high unmet needs and reduced satisfaction with care.[150] An increase in median hospice days was not observed among beneficiaries with LLE, potentially because survival following stroke is too brief for length of hospice use to be a modifiable outcome.

Patients who are most likely to benefit from palliative care had an increase of 17% in the odds of hospice enrollment among beneficiaries with LLE, however the predicted probability of hospice use within one year of stroke among ACO-aligned beneficiaries was only 2 percentage points higher than among non-aligned beneficiaries (21% and 19%, respectively). Current Medicare ACO quality metrics are not specifically tied to care for patients who are seriously ill or require EOL care, which may limit the resources MSSP ACOs allocate to programs targeting these patients with advanced illness. MSSP contracts incentivize palliative care indirectly at best through the potential for shared savings resulting from reduced resource use in other care settings. In ACOs where the seriously ill represent a small proportion of the defined ACO population, there is little financial incentive to improve palliative and EOL care provided to this group.

The small increase we found in hospice enrollment associated with the 2013 cohort of MSSP ACOs may be an early indication that the use of palliative care in Medicare ACOs will continue to grow over time. MSSP provided a pathway for gradually assuming risk for nascent ACO systems, and these systems may require years to fully implement care coordination strategies and effect change. In 2014, 76% of MSSP ACOs did not formally contract with a hospice or palliative care physician, and those that did were more likely to

have specialists (e.g., oncologists) in the network.[153] Unlike Medicare Advantage contracts, MSSP contracts include hospice expenditures in calculations of per capita costs. As a result, increases in hospice spending could contribute to overall cost increases if there are not corresponding decreases in other types of spending. On the other hand, ACOs may share in the savings when hospice use reduces costs at the end of life, and the potential for Medicare cost savings is greater under the tiered hospice payment structure implemented in 2016.[154]

Our findings should be interpreted in the context of several limitations. First, larger hospitals are more likely to participate in the GWTG–Stroke registry, so the generalizability to smaller, more rural institutions is limited.[58] Second, patient ACO alignment is not randomized, and assignment may be correlated with differences between the treatment and control group that are not captured by the observable characteristics—for example, education level or socioeconomic status—however, models were adjusted for county-level socioeconomic factors to mitigate the potential for bias. Finally, although the importance of palliative care concurrent with curative care is recognized, claims indicators of palliative care consultation have low sensitivity, so the registry-reported use of inpatient CMO should improve reliability.[68,69]

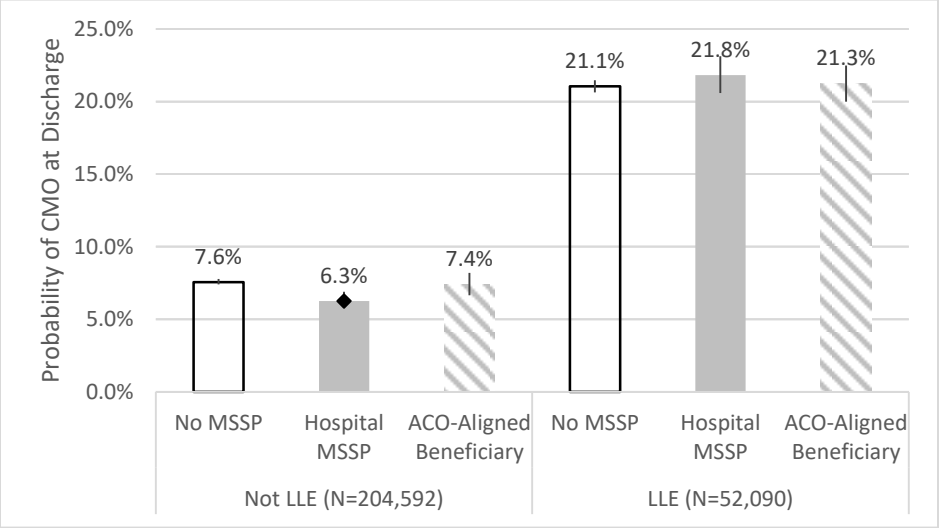
For patients with ischemic stroke, high-quality care includes advance care planning and family-centered care that recognizes the preferences of the patient and caregivers. Among ischemic stroke patients most likely to benefit from palliative care, MSSP was associated with increased hospice enrollment and inpatient comfort measures without increasing rates of live discharge from hospice. This balance between appropriate use in a targeted population and overuse of the benefit may be an early signal that MSSP contract incentives will motivate improved quality of EOL care.

Table 8. Characteristics of GWTG–Stroke Medicare Beneficiaries With and Without Limited Life Expectancy by Hospital MSSP Participation (2010-2013)

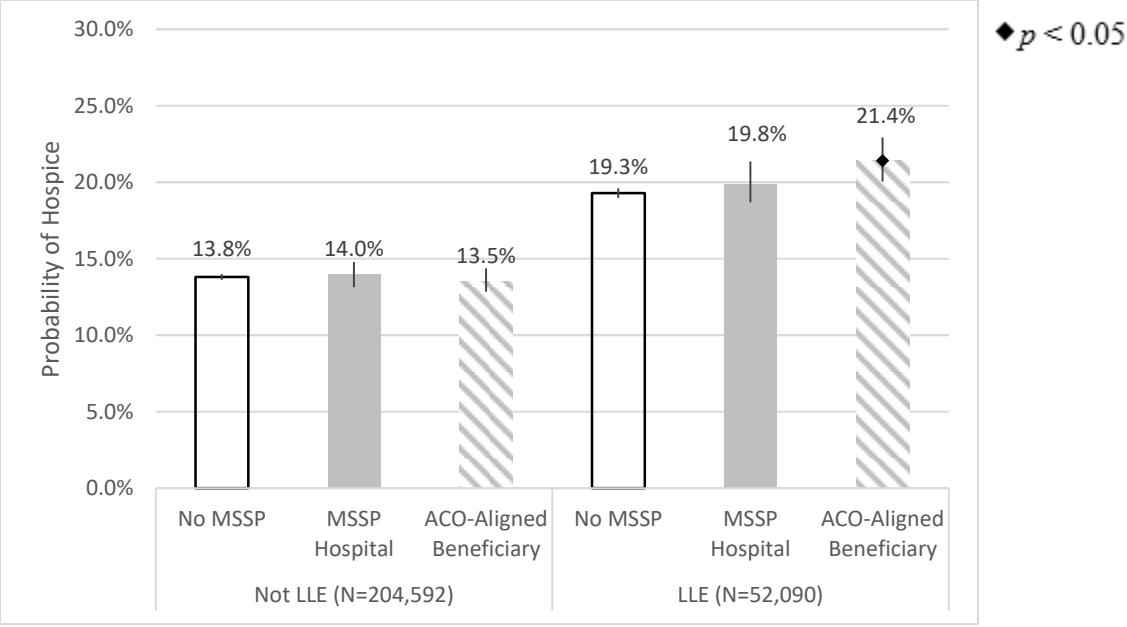
	Not Limited Life Expectancy				Limited Life Expectancy			
	Not MSSP		MSSP Hospitals		Not MSSP		MSSP Hospitals	
	N= 163,065		N= 41,527		N= 41,406		N= 10,684	
Variable	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Patient Characteristic								
Age, median (25th-75th percentiles)	79 (72,85)		80 (73,86)		84 (77,89)		85 (78,90)	
Demographic (%)								
Female	56.4		57.3		66.4		67.8	
Black	9.4		10.5		8.3		9.9	
Hispanic	3.8		3.6		3.9		3.5	
Asian	2.0		1.7		2.1		1.7	
Medicaid	6.9		6.6		8.9		9.4	
Private Insurance	36.3		41.4		34.5		38.2	
Inpatient Clinical Measures								
NIH Stroke Severity Score	4.0 (3.7)		4.0 (3.7)		20.2 (6.8)		20.2 (6.8)	
GWTG Mortality Risk Score	3.5 (3.5)		3.5 (3.5)		18.1 (12.1)		18.2 (12.2)	
Discharge to home, %	47.2		45.0		7.3		6.6	
Unable to ambulate, %	12.8		13.5		63.7		65.1	
CHA2DS2-VASc 2+, %	98.5		98.5		99.3		99.3	
Chronic Kidney Disease, %	49.2		49.0		57.5		57.9	
Body mass index	27.4 (6.6)		27.2 (6.3)		26.2 (6.8)		26.0 (6.3)	
Diastolic blood	71.4 (12.3)		71.4 (12.2)		70.7 (13.5)		70.7 (13.6)	
Systolic blood pressure	137.5 (21.1)		137.6 (21.0)		137.1 (23.3)		137.3 (23.2)	
A1C measurement (0-20), %	6.4 (1.4)		6.4 (1.4)		6.2 (1.2)		6.2 (1.2)	
High Density Lipoprotein (mg/dl)	45.1 (14.7)		45.8 (14.6)		45.4 (15.0)		46.0 (15.1)	
Low Density Lipoprotein (mg/dl)	97.3 (37.8)		96.8 (37.4)		92.0 (36.4)		92.0 (36.2)	
Heart Rate	78.8 (17.1)		78.8 (17.0)		84.1 (20.6)		84.1 (20.7)	
International normalized ratio	1.2 (.5)		1.2 (.5)		1.2 (.6)		1.2 (.5)	
Medical History (%)								
Atrial Fibrillation	22.2		23.0		44.9		45.6	
Carotid Stenosis	4.1		4.4		3.3		3.4	
Diabetes	32.0		31.6		28.4		28.2	
Peripheral Vascular disease	5.2		5.5		6.1		6.2	
Hypertension	84.3		84.7		83.1		83.7	
Smoking	10.8		10.5		6.4		6.4	
Dyslipidemia	49.8		51.1		40.9		41.0	
Heart Failure	9.8		10.0		18.3		18.8	
Transient Ischemic Sroke	10.0		10.0		8.5		8.8	
Family History of Stroke	2.1		2.4		1.3		1.6	
Hospital Characteristics								
Number of Beds	399.8 (271.5)		443.2 (283.2)		420.4 (289.2)		469.3 (297.8)	
Annual Stroke Admissions	312.4 (201.4)^		362.2 (245.1)		334.5 (211.9)^		384.0 (256.1)	
Rural, %	6.4		3.5		5.9		3.5	
Teaching, %	53.2 ^		66.6		56.9 ^		70.6	
Region (%)								
Northeast	24.7		31.9		24.5		31.4	
Midwest	20.4		25.3		20.6		24.0	
South	38.4		32.0		37.7		33.4	
West	16.5		10.8		17.2		11.1	
County Characteristics								
Total Population (log)	12.7 (1.5)^		13.0 (1.5)		12.7 (1.6)^		13.0 (1.5)	
Proportion Age 65+	0.14 (.04)		0.14 (.03)		0.15 (.04)		0.14 (.03)	
Proportion Households in Poverty	0.15 (.05)^		0.14 (.05)		0.15 (.05)^		0.14 (.05)	
# Primary care physicians (per 10,000)	7.7 (3.0)^		8.3 (3.3)		7.6 (3.0)		8.3 (3.3)	
Number of Hospice providers (per 10,000)	0.6 (.2)		0.5 (.1)		0.6 (.2)		0.5 (.1)	

^ Absolute value of the standardized difference between MSSP and not MSSP > 0.2;

Panel A: Comfort measures only (CMO) during hospitalization or discharge to hospice



Panel B. Hospice enrollment within 1 year of discharge



Notes: LLE=Limited Life Expectancy at discharge (defined as meeting one of the following criteria: National Institutes of Health Stroke Scale (NIHSS) score of ≥15; provider reported limited life expectancy as contraindication for treatment in GWTG-Stroke reporting; GWTG-Stroke mortality risk prediction score > 0.15). Average Marginal Effects were estimated using recycled predictions from logistic models and bootstrapped confidence intervals over 100 replications. All models are adjusted for patient demographics, stroke severity, health status at discharge, medical history, hospital factors, county factors, no evaluation and management visit the year prior to incident stroke, fixed effects for hospital referral regions and year/month of admission.

Figure 13. Predicted probability of comfort care among patients with and without Limited Life Expectancy (LLE) by MSSP status.

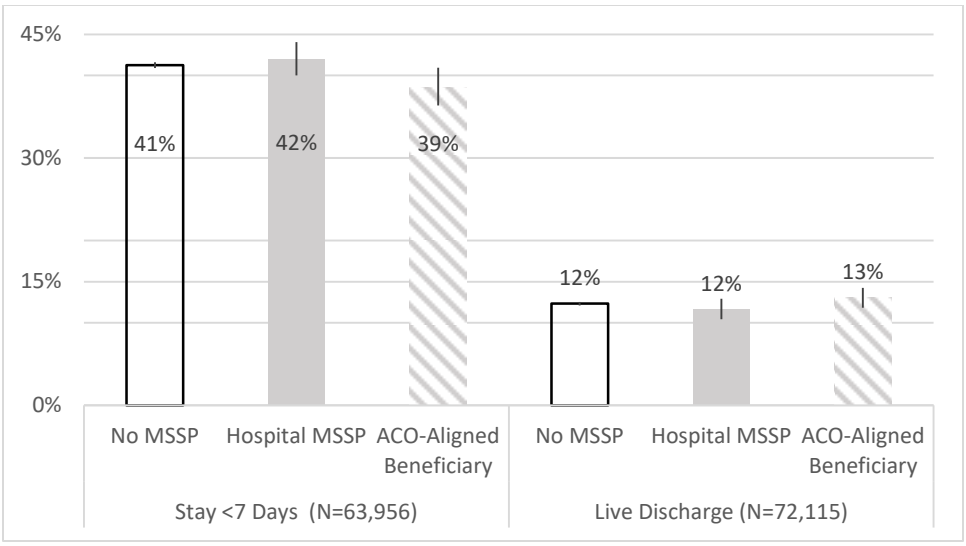


Figure 14. Probabilities of a short hospice stay and live discharge from hospice among hospice users.

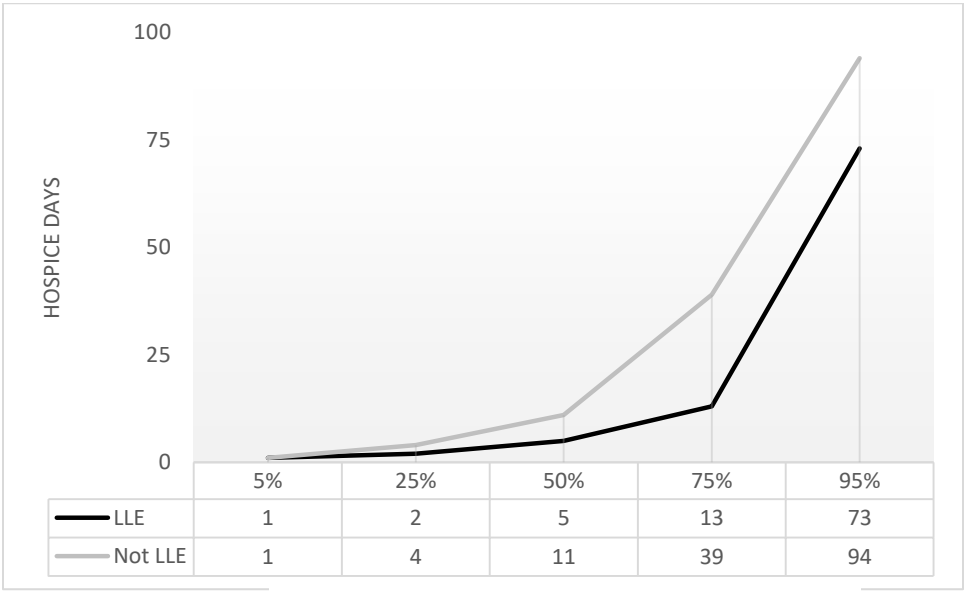


Figure 15. Distribution of days in hospice among LLE and not-LLE among hospice users.

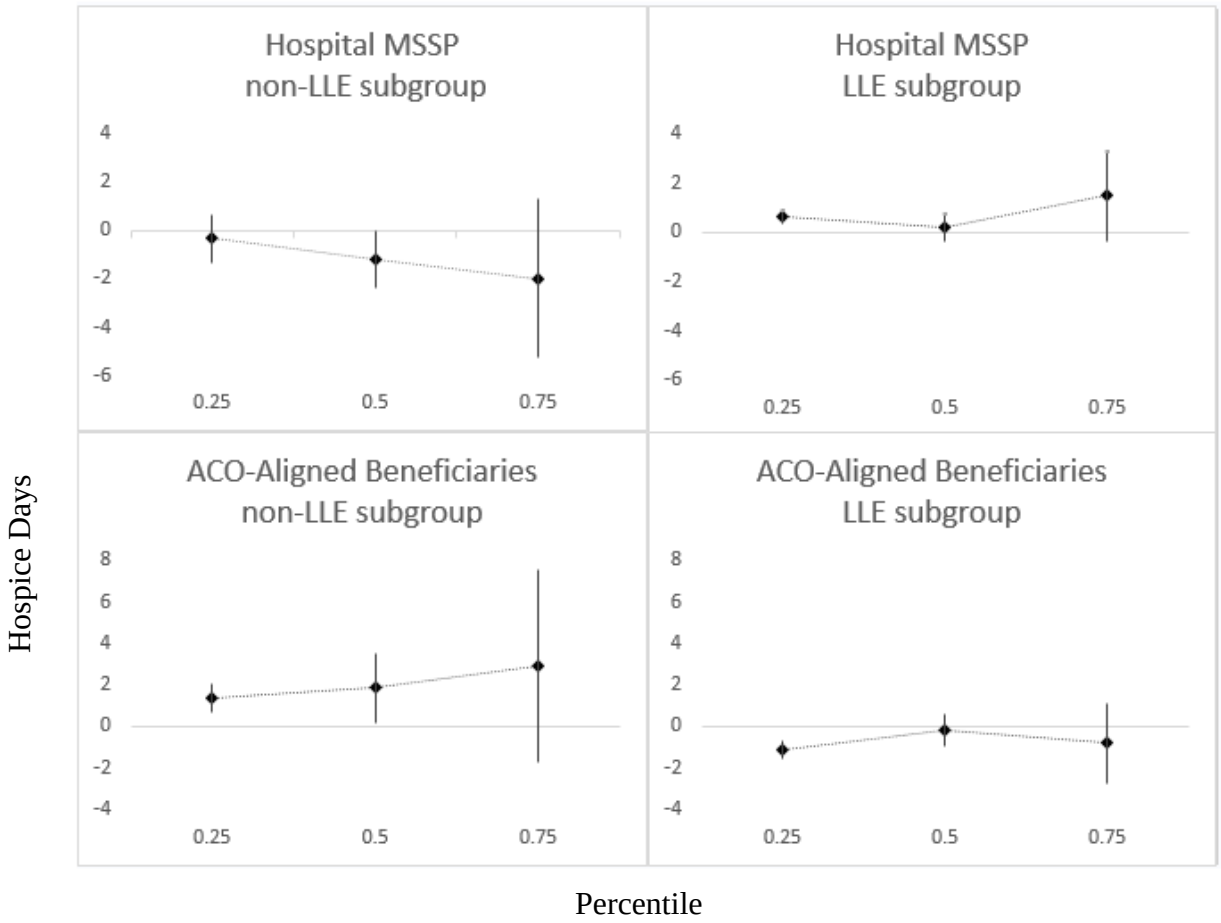


Figure 16. Shifts in total hospice days among hospice users by MSSP status at the 25th, 50th and 75th percentile for hospice days with 95% confidence intervals.

Table 9. Associations of Hospital MSSP Participation and Beneficiary MSSP Assignment with Hospice Use and Outcomes of Hospice Use Among Hospitalized Stroke Patients

Among patients with index hospitalization 2010-2013 (N=256,682)

1. Composite comfort care outcome	*Odds Ratio*	*Confidence Interval*
DD for Hospital MSSP		
LLE	1.06	(0.95,1.19)
Not LLE	**0.78**	**(0.69,0.90)**
Beneficiary MSSP		
LLE	1.03	(0.90,1.17)
Not LLE	0.97	(0.83,1.13)

2. Hospice claim within 1 year of hospitalization for stroke	*Odds Ratio*	*Confidence Interval*
DD for Hospital MSSP		
LLE	1.04	(0.93,1.16)
Not LLE	1.02	(0.94,1.10)
Beneficiary MSSP		
LLE	**1.17**	**(1.03,1.23)**
Not LLE	0.98	(0.89,1.08)

Among patients hospitalized 2010-2013 with hospice use within 2 years of discharge 2010-2015 (N=72,115)

3. Stay less than 7 days (N=63,956)	*Odds Ratio*	*Confidence Interval*
DD for Hospital MSSP	1.03	(0.94,1.14)
Beneficiary MSSP	0.89	(0.79,1.01)

4. Live discharge from hospice (N=72,115)	*Odds Ratio*	*Confidence Interval*
DD for Hospital MSSP	0.93	(0.81,1.08)
Beneficiary MSSP	1.06	(0.89,1.27)

Table 10. Association of MSSP Status with Total Hospice Days in the 2 Years Following Hospitalization for Stroke

Quantile	MSSP Status	Estimate	Lower CI	Upper CI	P-value
0.25	MSSP Hospital	-0.33	-1.31	0.65	0.50
	MSSP Hospital LLE	0.63	0.33	0.93	<.001
	AC0-Aligned	1.39	0.68	2.10	<.001
	ACO-Aligned LLE	-1.13	-1.58	-0.69	<.001
0.5	MSSP Hospital	-1.20	-2.38	-0.03	0.045
	MSSP Hospital LLE	0.19	-0.38	0.76	0.512
	AC0-Aligned	1.84	0.19	3.50	0.029
	ACO-Aligned LLE	-0.19	-0.94	0.56	0.616
0.75	MSSP Hospital	-1.97	-5.27	1.34	0.243
	MSSP Hospital LLE	1.49	-0.37	3.34	0.116
	AC0-Aligned	2.92	-1.74	7.58	0.219
	ACO-Aligned LLE	-0.82	-2.71	1.08	0.398
GLM					
Mean	MSSP Hospital	0.38	-1.32	2.08	0.664
	MSSP Hospital LLE	0.97	-1.35	3.28	0.413
	AC0-Aligned	1.42	-0.62	3.47	0.172
	ACO-Aligned LLE	-1.32	-4.16	1.52	0.362

MSSP=Medicare Shared Savings Program; LLE= Limited Life Expectancy subgroup; CI=Confidence Interval; GLM= Generalized Linear Model;

CHAPTER 6. SUMMARY, IMPLICATIONS, AND CONCLUSIONS

This research improves our understanding of the early impacts of the MSSP on acute care in the year following ischemic stroke. I expected to learn whether and how discharge from a hospital participating versus not participating in MSSP and beneficiary ACO alignment versus not were associated with outcomes following stroke. The combined results from all three aims suggest that MSSP is associated with higher intensity post–acute care and improved quality of end-of-life care among patients with stroke. The finding of increased use of SNF and IRF for beneficiaries discharged from MSSP hospitals and increased hospital admissions ACO-aligned beneficiaries is contrary to my hypothesis that MSSP would be associated with reduced acute care use. My findings are consistent with evidence that early ACO savings are not driven by reductions in use for complex, high-cost patient groups. This research provides insights for the effectiveness of the current MSSP incentives and raises the need for future research to better understand the role of MSSP in reducing fragmentation in post–acute stroke care as well as improving stroke outcomes.

6.1 Summary of Findings

My systematic review of the evidence for the effect of ACOs on care processes and outcomes is mixed, potentially due to the variability in contract incentives across payer programs and outcome measures. The incentives for efficiency within ACO contracts have not negatively impacted common care quality measures or patient satisfaction, however there is little evidence to support the hope that ACOs have fulfilled on their promise of improved care at reduced cost in the early years of implementation.

For both of my studies, I used an analytic dataset that linked the national GWTG–Stroke hospital registry data with Medicare claims files for one year outcomes, CMS MSSP beneficiary- and provider-level files for MSSP exposure, and the Area Health Resource File for local market factors. For all three aims, I employed a difference-in-difference method to evaluate the association of the MSSP with use, clinical outcomes, and quality of EOL care in patients with ischemic stroke. I used the GWTG data from the index hospitalization to differentiate a low mortality subgroup to evaluate long-term outcomes (study 1) and a high mortality, LLE subgroup to evaluate appropriate use of palliative and EOL care (study 2).

Study 1 evaluated the association of MSSP with use and clinical outcomes in the year following incident stroke. The analysis sample was restricted to patients with relatively low mortality risk to ensure a survival period of sufficient duration to observe potential impact of improved care processes. I found that rather than shifting post-stroke care to lower intensity care settings, hospital participation in MSSP was associated with a 6% lower rate of discharge to home. Most patients not discharged to home were discharged to either SNF or IRF for post–acute care, so a reduction in discharge to home suggests higher intensity and higher cost of care following stroke. Relative to beneficiaries not assigned to MSSP, the adjusted risk of rehospitalization and rate of subsequent admissions in the year following stroke for patients assigned to an MSSP increased by 3% and 5%, respectively. Despite the differential increase in rate of admissions following stroke, I did not observe a correlating increase in the total number of inpatient days.

Study 2 evaluated the association of hospital participation in MSSP and beneficiary ACO alignment with improved quality of EOL care following incident ischemic stroke. Among patients with low mortality risk (not LLE), hospitalization at MSSP hospital was associated with

reduced use of inpatient CMO or discharge to hospice. Among patients with low mortality risk, hospitalization at MSSP hospital was associated with a reduction in the use of inpatient CMO or discharge to hospice. For patients with low mortality who went on to enroll in hospice, the median length of use was nearly two days greater for ACO-aligned compared to non-aligned beneficiaries.

6.2 Implications for Policy and Practice

These results have multiple implications for practice and policy. First, current incentives in MSSP contracts may not be sufficient to generate changes in post-stroke outcomes or reductions in acute care use among stroke patients. Of the 33 MSSP quality measures in 2013–2014, two relate to patients with ischemic vascular disease.[144] However, fragmentation of care and medication non-adherence are not specific to stroke patients, and introduction of quality measures for specific diagnosis groups would further burden providers with quality reporting. Over the next few years, CMS is introducing MSSP quality measures to target patients with multiple chronic conditions, which includes many stroke patients. These new measures, including unplanned admissions and post-discharge medication reconciliation, may refocus ACOs on care for these high-cost groups.

Second, for hospitalized patients, hospital MSSP participation and beneficiary ACO alignment impact different aspects of the care trajectory. Across both studies, hospital assignment was significantly associated with outcomes proximate to the hospitalization (e.g., discharge destination), and beneficiary assignment was significantly associated with one-year outcomes that may be more likely to be impacted by outpatient care. I was surprised to find that the estimates for hospital MSSP associations were not sensitive to the inclusion of the beneficiary MSSP, suggesting that the acute care pathway is largely independent of primary care. In addition, there was no evidence of a benefit for ACO patients receiving acute care at the same

ACO providing their primary care. There may be an opportunity for ACOs to improve outcomes by further integrating acute care and post–acute care partners into successful outpatient care delivery models like the Patient Centered Medical Home.

Third, I found contrasting effects associated with MSSP in the subgroups of patients identified with high versus low mortality risk, specifically for use of comfort measures and hospice enrollment. As a result, ACOs may increase use of palliative care among those most likely to benefit without increasing hospice days or cost across the Medicare population. Although these effects were small in magnitude, the vast majority of ACOs in this study participated in Track 1 contracts, which include shared savings but no downside risk. MSSP impacts on quality and outcomes may be magnified as ACOs gain experience and transition to risk-bearing tracks of MSSP or Next Generation ACO contracts.

6.3 Next Steps and Future Research

Although these early results are valuable signals to predict the potential impact of MSSP on care and outcomes, the long-term impacts of the program may change as ACOs become more integrated and payer contracts evolve. This study evaluated acute care use and EOL care, but the impact of MSSP on cost, use of high-quality post–acute care facilities, and quality of life following stroke is unknown. As Medicare ACO contracts evolve, studying the impact of changes in assignment methodologies and risk adjustment will inform implementation of the ACO strategy. Finally, the potential for unintended impacts on existing health disparities should be considered as alternative payment models are defined and implemented.

The observed increase in use of inpatient care following stroke may reflect greater use of IRF, which has been associated with improved patient outcomes, as opposed to less intensive care settings (e.g., skilled nursing facility or home health).[141] In addition to controlling costs, ACOs are expected to be a vehicle for creating high-quality referral networks, increasing use of

providers with a pattern of high-value care. Little research has explored how referral patterns have been impacted by dissemination of the ACO model.[109] Among patients with serious illness, the relationship between cost and quality is another source of uncertainty. As ACOs seek to improve care coordination in post-stroke care, the financial incentives for cost reduction could either promote or hinder improvements in quality of care depending on the implications of quality for CMS reimbursement.

As Medicare ACOs transition to prospective assignment contracts, more decedents are likely to be included in the defined population used to evaluate ACO performance. The extent to which this change will impact health systems' approach to population management is unknown. We defined beneficiary ACO alignment using claims prior to the period over which outcomes were assessed, which includes a patient population similar to a prospective assignment methodology. In a prospective assignment contract, beneficiaries who die during the ACO performance period are just as likely to be assigned as those who survive the performance period, however, in a retrospective claims-based assignment contract, decedents are less likely to be assigned than those who survive due to a reduction in the time over which they generate the FFS claims used in the assignment algorithm. If patients with advanced illness and approaching the end of life represent a larger portion of the population in prospective contracts, then ACOs may have greater motivation to target these high-risk groups with care management programs as CMS increases use of prospective assignment.

Finally, future research should examine unintended impacts on disparities. Provider participation in ACOs is lower in poorer communities and safety net providers are less likely to generate savings in alternative payment models when they do participate.[155-157] Furthermore, high-spending ACOs generate more savings than low-spending ACOs, potentially rewarding

systems starting with greater inefficiency.[158] Contributing to these undesirable financial impacts, ACOs serving minorities lag on quality standards for savings eligibility.[159]

Providers serving vulnerable populations often have fewer resources available to fund quality improvement programs and information technology. They may also face challenges in meeting the broad needs of their patient populations due to social determinants of health, particularly in rural areas with fewer community resources available to support the healthcare system and higher comorbidity burden. Hospitals participating in ACOs tend to be large and urban, and the unequal distribution of ACOs across rural and urban areas may widen the disparity between these groups as well.[160] The Advance Payment Model has facilitated dispersion of the ACO model to smaller organizations with fewer resources, and policy makers should continue to explore additional strategies to both encourage participation and fairly compensate ACOs serving vulnerable populations. In addition, research should inform policies that will counteract the potential for the pay for performance aspects of ACO contracts to further shift resources away from deprived markets.

6.4 Conclusion

This study provides modest evidence that ACOs positively impact quality of EOL care among ischemic stroke patients with high mortality risk but failed to find evidence of improved clinical outcomes or reductions in acute care use. Given the rapid adoption of the ACO strategy nationally, it is essential that we understand the relationship between ACOs and stroke outcomes. Further studies are warranted to assess the downstream impacts of ACOs and other alternative payment strategies on patient centered outcomes, particularly in patients with advanced illness.

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